REPORT OF THE SECRETARY OF AGRICULTURE

•

1937

Report of

THE SECRETARY OF AGRICULTURE

1937

WASHINGTON, D. C.

UNITED STATES GOVERNMENT

PRINTING OFFICE

For sale by the Superintendent
of Documents, Washington, D. C.
Price 15 cents

Contents

The Report of

THE SECRETARY OF AGRICULTURE

1937

WASHINGTON, NOVEMBER 1, 1937

To the President

SECURITY FOR FARMER AND CONSUMER

In this, my first report in the second term of your administration, I wish to depart somewhat from the usual form of the annual reports of the Secretary of Agriculture. Instead of beginning with particulars of the year's production, and of farm prices and farm income, I wish to emphasize certain principles that 5 years of agricultural and industrial recovery has clarified and demonstrated. In large measure this recovery has resulted from the fostering of group solidarity among farmers, wage earners, and businessmen. Federal legislation has given expression both to agricultural and to urban group-solidarity.

Something more, however, remains to be done. It is necessary to obtain in legislation, not only a more effective expression of various group interests, but also more adequate recognition of the interdependence of the major economic groups. Our democratic form of Government functions most effectively when national policies reflect different group needs in due proportion, with group unity as the basis of intergroup cooperation. Therefore, I begin this report with an analysis of the community of interest that exists between farmers and city dwellers. On this foundation, with the tools of group unity used in truly democratic processes, we can begin to build security for farmer and consumer.

Farmers and city dwellers live in the same world of economic instability. There is no basic antagonism between town and country; there is not even true rivalry. Country and town are complementary and interdependent. This is elementary; but elementary truths need sometimes to be reemphasized. Country and town tend to forget their ultimate common interests, and to overemphasize their apparent momentary differences.

Country and town have the same need for an increasing, properly balanced production, and for an expanding market adequately supplied with buying power. Neither can profit by victimizing the other, or by conditions that give one or the other an undue temporary advantage.

For selfish reasons many people try to drive wedges between farmers and laboring men and between farmers and businessmen. This is not difficult. People who live in cities easily forget that their income goes up and down with the income of the farmers, just as the income of agriculture goes up and down with the pay rolls of labor. Consumers naturally want to buy as cheaply as possible. Generally they do not understand that, pushed to an extreme, this desire may rob them of buying power, through its effect on agriculture's ability to purchase the products of the cities. Conversely, farmers who demand excessively high prices for farm products, and who simultaneously object to high wages for city workmen, show a lack of understanding of their true interests. When we penetrate beneath the superficial conflicts that divide country and town, we come to a bedrock of rural-urban interdependence.

Farm Income and Factory Pay Rolls

Trends in farm income and factory pay rolls show this clearly. Farm cash income dropped more than 6 billion dollars between 1929 and 1932. In the same period factory pay rolls for the country as a whole dropped 6½ billion dollars. These slumps were the result of the same forces and reflected a profound maladjustment in the rural-urban relationship. As the maladjustment disappeared, both rural and urban incomes rose. Between 1932 and 1937 the farm cash income increased by nearly 5 billion dollars and factory pay rolls by about the same amount. Farm income and factory pay rolls have moved up and down together in the United States for many years, and the correspondence of the totals has been very striking. Still more important, farm income and factory pay rolls invariably go up and down together in about the same proportions, in a manner that continually demonstrates the fundamental identity of rural and urban interests.

Farmers and city dwellers may best promote their common interests by cooperating to bring about a continuous balanced increase in the national production. This holds for both fields and factories. True, there is less room for expansion in agricultural than in industrial production. Ultimately, the growth of population limits the need for farm commodities, whereas the only limit to the demand for many industrial products is the extent to which consumer buying power can be increased and diffused. Many consumers could use more farm products than they do today if they had more purchasing power. But an increase in the purchasing power of the urban low-consumption group can come about only through increased industrial activity and increased wage payments.

Fortunately, people are coming to recognize these aspects of the problem. They see that the neglect of agriculture in the national policy would threaten an enormous investment, concentrate population excessively in the cities, dislocate many industries that depend on agriculture directly, and change the rural-urban balance disastrously. Farmers as well as city people realize, too, that the consumers' interest must be protected. Attempts by farmers to exact unduly high prices for inadequate supplies

would not produce the income they desire and would inflict unmerited hardship on the poor.

Farm and Factory Relationship Is Complex

Needless to say, the relationship between agriculture and industry is complex and involves more than the natural opposition of buyers and sellers. Consumers should be interested, not only in the prices they have to pay for agricultural products, but in the income that agriculture gets as a result. When agriculture receives too small a share of the national income, it ceases to be a good market for factory products and urban unemployment results. In 1937, when farmers comprised about 25 percent of the population, farmers received less than 11 percent of the national income. They received much more than in 1932; but if we take the pre-war relationship as a criterion, they were still short of their fair share by about a billion dollars. They could not purchase their normal quota of industrial commodities.

We cannot say that the farmers' income should average the same in dollars as nonfarmers' income. Money goes farther on the farm than in the cities; moreover, farming provides substantial nonmonetary incomes, such as food and fuel produced for consumption on the farm, and various intangibles for which city people have to pay dearly. It is undeniable, however, that farm income is not yet back to what it should be. Before the war farmers ordinarily received per capita about half as much income as the gainfully occupied in the nonfarm population. In 1929 they received per capita only about 45 percent as much as the nonfarmers, and in 1932 only about 25 percent. Their income this year, with Government payments included, will lift them back to where they were in 1929, but not back to where they were before the war. When the farm income is below the pre-war parity, country people will usually flock to the towns if they can and will increase the competition for city jobs. This tendency, besides forcing down wages, diminishes the rural demand for industrial commodities.

Very High Farm Prices Unstable

On the other hand, the farm proportion of the national income should not be too high. Above a certain level it cannot be stable. Suppose, for the sake of illustration, agriculture with 25 percent of the population received say 25 percent of the national income. That would necessitate a very high level of farm-commodity prices and would force city people to pay exorbitant prices for their food and clothing. Two forces would operate at once to swing back the pendulum. (1) City people would look abroad for supplies and would agitate for lower tariffs on agricultural commodities; (2) farmers would plow up every possible acre. With wheat at possibly $2 a bushel, corn at $1.50, cotton at 30 cents a pound, and hogs at 15 cents, agriculture would swamp the available market, domestic and foreign, in no time. One or two years of normal growing weather would pile up surpluses and force down the agricultural price level.

Such considerations, though entirely obvious, need constantly to be borne in mind; otherwise, the necessary stability in rural-urban relationships cannot come about and the country swings inevitably from boom to depression, and toward conditions in which depression predominates. Both

country and town frequently neglect to study the rural-urban relationship as a whole. Particular aspects of it claim disproportionate attention. Food prices, for example, are much higher now than they were in 1932, and many consumers believe they are paying too much. Some farm commodities are quite high as a result of droughts in 1934 and 1936. Nevertheless, incomes of city dwellers have risen more than their food bills during the last 5 years. These incomes have increased about 15 billion dollars, whereas the retail-food bill has gone up only about 3 billion dollars. Food at retail in 1937 absorbed only about 20 percent of the income of town and city consumers, a smaller percentage than in 1929 or in any year since then. Narrow views distort the picture.

Influence of City Wage Rates

Farmers sometimes object to the wages demanded by factory workers. High industrial wages, they think, mean higher prices for industrial products. This is not necessarily the case, for there is a tendency for increased labor cost to be offset by greater efficiency; but even if it were, the farmer would need to balance the disadvantage of paying a little more for industrial commodities against the much greater advantage of having an adequate market, well supplied with purchasing power, in the industrial communities. Low urban wages might possibly mean cheaper farm machinery, cheaper automobiles, cheaper clothing, and cheaper furnishings; they would certainly mean restricted urban purchases of agricultural commodities. The correct balance is what agriculture needs, rather than a permanent disparity in its favor.

Agriculture benefits when profits and wages are satisfactory in industry just as industry benefits when satisfactory farm prices maintain the purchasing power of the agricultural population. Records have been obtained from a group of industries that employed 17,000,000 persons in 1937, as against 12,700,000 in 1932. These industries paid each employed worker an average of $207 more in wages in 1937 than they did in 1932. The average figure for 1937 was $1,277; for 1932 it was $1,070. With his increased income the employed wage earner paid about $87 more for his year's food bill; he contributed that much to the restoration of agricultural prosperity. In addition, he had $122 more available for other items. All told, he was able to buy 12 percent more foods and services than in 1929. With foreign outlets for American agricultural products declining, it is fortunate that the domestic market provides some compensation.

Need for Rural-Urban Balance

Health in the economic system demands a balance between industrial and agricultural production. Balanced production in an increasing volume depends essentially on the correct distribution of the national income. There is no point in urging that either branch of production should produce without limit, and without regard to the effective demand. Some people say farmers should grow more and more, regardless of the limitations of consumer buying power, until the last hungry Chinese has been fed and the last naked Hindu clothed. But that course, instead of feeding the hungry Chinese and clothing the naked Hindu, would bring millions of Americans to hunger and nakedness, because it would destroy agriculture's income. We saw this demonstrated in 1932, when the agricultural bins

were bursting. That was a year of bankrupt farmers and lengthening bread lines. The droughts of 1934 and 1936 taught the people another lesson and showed the importance of maintaining adequate reserves for the protection of the consumer. Consumption both of agricultural and industrial products depends on the volume and the distribution of purchasing power, and particularly on its distribution between town and country.

Agriculture is working toward greater stability in supplies and prices and toward the protection of the consumer through the maintenance of an ever-normal granary. Both Houses of Congress have assented to a joint resolution favoring the enactment of the necessary legislation. This should include protective devices for both farmers and consumers. Ever-normal-granary legislation, besides helping to smooth out the swings of agricultural production and prices, and to regulate the marketing process, would tend also to promote a balanced increase of industrial products; because it would give manufacturers some assurance of a steady agricultural market.

Adjustment in Industry

In an ideal rural-urban balance urban production doubtless would come also under forces making for stability of output and prices. Industrial production fluctuates normally much more than agricultural production, and the fluctuations throw the economic system out of balance. Industrial production, under the present scheme of things, cannot be expanded indefinitely. Practically, the limitation of purchasing power controls the development of industry just as it controls the development of agriculture. Heretofore, most efforts at economic adjustment, both in agriculture and in industry, have looked toward reduction of the output, as a means of sustaining prices. The great problem is to discover how adjustment may promote balanced expansion, so that labor, capital, and natural resources can be employed and at the same time conserved.

This ideal can be expressed in a formula which runs as follows: Our national economic goal must be increased balanced production of the things that people really need and want (1) at prices low enough so that consumers can buy but high enough so producers can keep on producing, (2) with income so distributed that no one is shut off from participation in consumption, except those who refuse to work, (3) with scrupulous regard for the conservation of our remaining natural resources, and (4) by means characteristic of our traditional democratic processes.

Intergroup Cooperation

As farmers make their contribution to this aim under ever-normal-granary legislation, other economic groups should cooperate in working out complementary procedures. It may be difficult to discover the exact industrial counterpart to the ever-normal-granary program; but socially minded businessmen with the assistance of industrial engineers and economists will not be slow in attempting to develop an experimental approach. Consumers have a right to expect this contribution from industry just as they have a right to the protection of the ever-normal-granary principle in agriculture.

Agriculture, labor, and capital must give allegiance to increasing balanced production and full, continuous employment on which all of our welfare depends, if we are to solve the dilemma of prices, wages, and profits. This

particular problem is not one with which our Founding Fathers were confronted. As long as there was a frontier and free land, the problems of labor, agriculture, and capitalism were simple. Today the fundamental principles of the Founding Fathers are as good as they ever were but the details of the problems to be met are completely outside of the range of vision of the Founding Fathers or beyond any of the precedents to which the Supreme Court may refer. We must take the guiding principle of unity of purpose and reconciliation of diverse interests for the purpose of preserving democracy, and project it forward as a powerful light by which we may discover the methods of enabling farmers, laboring men, consumers, and capital to work together in a harmonious way, to bring about that security, that balanced abundance, that equality of opportunity, and that democracy which the signers of the Declaration of Independence and of the Constitution visioned as the very essence of the Nation which they had conceived and brought into being.

FARM UNITY AND DEMOCRACY

Modern agriculture with its specializations, its regional interdependence, its need of world markets, and its involvement in the money economy, has problems that are common to every part of the country.

All farmers have to concern themselves about farm prices and farm incomes; about the swings in production that result from seasonal changes in the weather; about developments in international trade; and about agricultural diseases and pests. They trade among themselves, as well as with city people. Wheat and corn growers buy cotton or cotton goods; cotton farmers obtain grain and meat from the Middle West; orchardists buy fruit from one another, as well as grain, meats, and dairy products from other producers. All have a natural solidarity.

This community of purpose was rudimentary not many years ago; it is now the basis of Nation-wide farm cooperation. Farmers have a sense of the need for concerted effort, and considerable experience in applying it. Cotton and tobacco farmers work with wheat and corn farmers, in a general movement for the advancement of agriculture in all ways consistent with the general welfare. Country and town are partners; each needs the other both as a market and as a source of supplies. But farmers realize that the welfare of both in the modern economy depends on cooperative, coordinated effort, and that it will not result automatically through blind competition. Congress passed the Agricultural Adjustment Act of 1933, which had reference primarily to the basic export crops, in response to this feeling.

Agricultural unity received further recognition in the Soil Conservation and Domestic Allotment Act of 1936, which enabled all farmers and stockmen to benefit increasingly from Federal farm programs.

Even Keel for Agriculture

It is time lost for the farmers to try to get that which is not for the long-time welfare of the Nation. Farm solidarity means united agricultural thought and action for the general welfare, rather than simply for the promotion of limited farm objectives. On this basis, the time has arrived when the farmers of the United States can begin to build for the longer

future. With their experience under the Agricultural Adjustment Act and the Soil Conservation Act to draw upon, they can devise a farm program that will keep the agricultural industry on an even keel.

This program must guard against shortages as well as surpluses. Our agricultural supply situation is very different now from what it was 4 or 5 years ago. Supplies of most foods and feeds are not excessive, and the continued assent of consumers to farm programs designed to give farmers a fair and stable income will depend on the willingness of the farmers to produce enough to keep the granaries full. The storage of reserve supplies, for the maintenance of an "ever-normal granary", is the farmer's duty to the consumer, which the latter may requite by helping to safeguard farmers from bad results when the granary overflows.

Farmers may get behind the principle of the ever-normal granary in the knowledge that its benefits will not be for themselves alone, but for industry and labor as well. It will probably be most useful with corn and wheat, though in a different way it may be applied also to cotton. Both farmers and city people have an interest in carrying over surpluses from big crop years into small crop years, so that prices will not go as high as they otherwise would in the short crop years, and will not go as low as they otherwise would in the big crop years.

Farm Objectives

Farm objectives that harmonize with the general welfare include the following:

(1) Farmers should have a share in the national income which will give the average farmer as much purchasing power relative to that of the average nonfarmer as he had before the war. This is in the interest of nonfarmers too. The whole Nation suffered when the cash income of our farmers in 1932 was only a little over 4 billion dollars. The whole Nation benefited when this income was nearly doubled in 1936. In the long run there can be no prosperity, in a State or in the Nation, that does not include farm prosperity.

(2) The people who live on the land must have security of tenure, either as owners of land or as renters on a long-time basis when they have demonstrated their farming ability and commercial morality. Farmers of good character must be able to borrow at reasonable rates of interest.

(3) The soil must be used properly and conserved for the sake of future farmers and future city people. This country has no use for ghost farms and ghost towns. Over the entire country, the triple-A program helps to make it possible for farmers to afford the adoption of soil-conserving practices. The establishment through State action of soil-conservation districts according to watersheds helps to coordinate the work in particular land-use regions.

(4) Farmers through sound cooperatives must come into control of those marketing, processing, purchasing, and service functions which they can manage efficiently. The cooperatives should be built from the ground up. Government help should consist chiefly of seeing that the rules are fair and that credit is available on a sound basis.

(5) Family sized farms should be favored by Federal programs that have to do with benefit payments and other such aids to rural income. The family sized farm is most in keeping with the traditional American system.

Maladjustments in our economic system distort the system, and make it increasingly difficult to maintain.

(6) Federal and State money should continue to be spent to promote agricultural research and better farm efficiency. The importance of continued research in agriculture is demonstrated by the tremendous technological advances of the past few years. Machinery has constantly been put to new uses. The biologists, the plant and animal breeders, and the chemists have done remarkable things. Agriculture must never stop the march toward betterment through science.

New Needs of Maturing Economic System

To such a platform for farm solidarity neither fair-minded laboring men nor fair-minded businessmen can object.

On such a program the whole of agriculture—owner operators, tenants, and farm laborers—can solidly unite. Around the national council table agriculture can make a significant contribution. Farmers work with their own hands and know what it is to sweat. They can sympathize with labor. They buy machines and must manage and plan if they are to sell at a profit. They can therefore sympathize with the businessman. Farmers and their relatives who live in the small towns and cities are the balance wheel of the Nation. Not only in an economic sense but in a psychological sense, farm security determines the national security—and farm sentiment determines the national direction.

Our maturing economic system has brought with it new demands which cannot be met by the old self-sufficiency and the old individualism. Group interdependence has become the cornerstone of the new economy. Individuals, groups, and geographical sections are so closely related that upon the welfare of one depends the welfare of all. Agricultural prosperity means industrial prosperity, and industrial prosperity means good markets for farmers. Industrial and agricultural welfare are bound in together, and neither farmers nor city workers can prosper without mutually aiding one another.

PRINCIPLES OF CROP ADJUSTMENT

This year's large production of wheat, corn, and cotton has reemphasized the necessity for a permanent crop-adjustment policy. It is again obvious that in years of normal weather our farmers can produce more of certain leading products than the market will absorb at prices remunerative to the growers. The extreme droughts of 1934 and 1936 temporarily obscured this truth. They led to some apprehension in nonfarm circles that crop adjustment might mean scarcity. One season of normal growing conditions has sufficed to dispel that fear, and to demonstrate once more that our agriculture for the most part is on an export basis, and depends on foreign markets to absorb a considerable proportion of its output of cotton, tobacco, wheat, pork products, dried fruits, and other commodities.

There is no danger of domestic shortage that cannot be obviated by maintaining an ever-normal granary. As in the past, our agricultural production, in all the lines above mentioned, tends constantly to overflow the domestic market and to bring prices determined in strenuous international competition. Our agricultural plant is more than adequate in manpower, equipment, and soil productivity to satisfy the home demand for

products that can be grown here advantageously. Therefore, the continuing problem of the farmer in the prevailing world market situation is to prevent low prices abroad from beating down the return for all that he produces. Without assistance in bringing about greater stability in agricultural supplies and domestic prices, the farmer loses when he produces adequately for the domestic market.

Flexible Continuous Adaptation

Commercial agriculture needs a flexible, continuous adjustment to domestic and world market conditions. Wise public policies can promote this end substantially. It cannot be achieved wholly through public measures. Much remains for the individual farmer to do, through good farm management and good land use. Indeed, the proper role of Government in agricultural adjustment is not yet well defined. It seems clear, however, that national programs, based on adequate economic research, can contribute greatly to the adjustment of farming both to long-time trends and to the temporary situations that result from accidental and cyclical variations in yields, supplies, and prices. Efficient crop adjustment to long-time trends awaits a more general realization of the necessity for it and the adjustment to temporary variations in the market can never be precise. But our experience with the original A. A. A. programs, and subsequently with the national soil-conservation program, shows that concerted action under public guidance can accomplish more than farmers can accomplish individually in preventing alternate gluts and shortages.

Continuous adjustment of supplies of farm products is a many-sided problem, the various facets of which must be treated separately. This requires special programs and special types of action for the different leading commodities. Commodity programs may be combined with types of action directed toward farm-management goals, and toward the conservation of resources. First it is necessary to outline the requirements on a regional basis with due consideration to the comparative advantages of different localities, and also with an eye to the resulting total balance of supplies. Then it will be easier to work out the programs for the several commodities. These programs will frequently necessitate adjustments in marketing, as well as in production. It is dangerous to overemphasize any one solution, such as rigid production control for the support of prices, or commodity loans that may tie up supplies in storage. All the elements of the adjustment policy must fit into a harmonious combination.

Major Requirements

Existing legislation does not provide adequately for continuous adjustment of crop and livestock supplies and its revision will be undertaken when Congress reassembles. It may be useful, therefore, to reemphasize the major requirements. It is fundamental that our agriculture should provide adequate supplies of food and fiber for the Nation and for such foreign trade as can be obtained, and the possibilities in the foreign market should not be underestimated. Moreover, permanent agricultural prosperity implies a full utilization of our farming resources, consistently with the proper conservation of our human and material resources. It follows that the coercive restraint of production should only be a last resort. Cotton, some types of tobacco, and certain other products depend so heavily on export outlets that

to restrict their production excessively would be very unwise. Such action would not keep up the prices of these commodities for any length of time, and would turn the world market over more and more to foreign producers. Then it would be necessary to restrict production in this country still more. Nevertheless, crop-adjustment powers should be available for emergencies; otherwise recurring surpluses will involve recurring disaster.

Another basic requirement in continuous crop adjustment is machinery through which farmers may carry forward voluntary cooperative programs that are in the public interest. Such machinery enables farmers to reconcile the conflict between their interests as individuals and their interests as a group, and to effect substantial adjustments, without resorting to coercive or restrictive measures. It should probably include provision for continuing adjustment payments. Such payments serve to equalize the costs of cooperative adjustment and to offset the farmer's natural incentive to produce all he can. They are the logical alternative to compulsory methods, and can be varied to meet different situations. Growers of certain commodities can be helped more effectively, for example, by the use of public funds for "surplus removal" than through direct adjustment or conservation payments.

Farm Income the Criterion

Another principle in adjustment policy, often overlooked, should be kept in view. Agricultural programs must be judged by their effect on income—farm income and national income. This is not synonymous with their effect on prices. Income may be sacrificed through over-emphasis on prices. Individual farmers know well that the reward for their season's work depends not only on the unit prices they receive for their commodities but on how many units of production they sell. This is true for agriculture as a whole and for its different branches. There is no point whatever in lifting prices above the purchasing power of the consumer. High prices sometimes may mean low sales. It is imperative to strike the golden mean, and to balance price against volume in such a way as to get the largest net return consistent with good farming practice.

This is a national as well as an agricultural problem. Excessive restriction in farm production, for the sake of raising prices, throws agricultural labor out of employment. When the displaced labor can find no other work, it becomes a charge upon the Nation. It does no good to save labor and then throw it on the scrap heap. Crop-adjustment programs under the A. A. A. did not aim at excessive restriction. Even cotton, the output of which was restricted sharply, was always in ample supply. True, the 12-cent loans of 1934 withheld much of the supply from the market, and perhaps gave some encouragement to our foreign competitors. But the crop-limitation program was not excessive in view of the accumulated supplies of cotton. It is not likely that adjustment programs in the future will sacrifice income unduly to price through excessive restrictions on the output. Nevertheless, it is well to bear in mind that the danger of doing so exists.

Restrictive Measures Normally Unnecessary

In a permanent agricultural adjustment policy restrictive measures may not be necessary except as a corrective measure when supplies become excessively large. Sudden emergencies may require special action. In the

main, however, it should be possible to get a balanced output through long-time adjustments based on good land use. Price considerations will not need to be overemphasized, at the expense of income or in a manner contrary to the public interest. In the long run, agriculture will profit best through balanced, adequate production with the available plant in full effective use. Needless to say, this involves proper care for conservation.

Adjustment requirements vary among the principal agricultural regions. In the north-central corn and livestock region it should be possible to bring about greater stability of income along with an adjustment of supplies primarily to domestic markets through a continuation of the present conservation program, the use of commodity loans, and in emergencies the application of more direct marketing or production control. Corn production lends itself well to the application of the principle of the ever-normal granary. With commodity loans and the storage of supplies in years of exceptionally large production, it will be possible to moderate the familiar cycle in which the prices of feed grains and of livestock vary inversely. Other parts of the same general region, particularly the dairy and poultry areas, would benefit from this stabilization of feed supplies and prices. Occasionally measures might be necessary to compel the compliance of minorities with the general program; but the main dependence should be on voluntary adjustment methods.

Problem in Wheat Areas

In the wheat areas of the Great Plains and the Northwest, different types of programs will be necessary for the different types of wheat. For the hard wheats the ever-normal type of loans will be appropriate; for the white wheats of the North Pacific area, special treatment will be necessary to retain or regain export outlets. There should be emphasis on the return of submarginal areas to grazing or to the public domain. In areas where normal yields warrant continued wheat production, there should be a self-sufficing crop-insurance program. The Government can well afford to carry the overhead expenses, as a means of reducing other forms of relief to wheat growers.

Cotton Requirements

In the cotton States the program should recognize the importance of retaining foreign markets and should avoid action that might endanger them. It should encourage conservation and balanced farming. The ever-normal-granary type of loan is not generally applicable to cotton. Loans at less than the market value may be useful occasionally, provided the lending agency is prepared to move the commodity into the market. It is preferable in some circumstances to do this at a loss, rather than to tie up supplies and accumulate carrying charges. It may be necessary to minimize the effect of low world prices by the continued use of price-adjustment payments on domestic allotments of cotton, or at a lower level on the entire crop in years when world supplies are large and prices low. Cotton growers in the United States have to pay production expenses and other costs determined in the highly protected domestic market. As an offset, they should have safeguards against the tendency of the world cotton market to fix the price of their total production at a low level. A moderate processing tax on the domestic consumption of cotton could furnish the means for adjustment payments conditioned on conservation or balanced farming.

Different Methods for Other Crops

With tobacco, rice, and peanuts continuation of the present conservation program seems to be desirable. These programs include acreage limitations or goals. Marketing quotas for tobacco and rice, with penalties for marketings in excess thereof, may be necessary when supplies are excessive. This factor can be applied very well to tobacco and rice, because the acreage of those crops is the principal determining factor in production and marketing. Some rice may be diverted into relief channels, and additional outlets may be found for American rice in foreign markets. With peanuts, it is practicable to divert the surplus into byproducts, and to strengthen prices without rigid control of acreage or marketing.

In dealing with fruits, vegetables, and potatoes the main approach must be through marketing programs. Vegetable growers and potato producers may usefully participate in the general soil conservation program. It is impossible, however, for them to depend exclusively on soil conservation and farm management programs as a means of stabilizing the supplies and prices of their commodities, because the yields fluctuate widely. Marketing agreements provide facilities for adjusting the volume of shipments and eliminating low-quality products from the commercial movement. Surplus-removal programs, including the purchase of temporary surpluses for distribution through relief agencies, may be appropriate when yields are excessively bountiful. There is room for more cooperative marketing of fruits and vegetables. Opportunities exist, which should be better developed, for the utilization of surpluses through coordinated effort by handlers, producers, and consumers.

In the dairy industry it seems appropriate to continue the conservation program in the Northeast and Lake States dairy regions and to put more emphasis on practices that will safeguard resources and reduce production costs. Producers' organizations and Federal and State agencies can cooperate effectively in efforts to stabilize prices and reduce distribution costs. In periods of excessive supplies surplus-removal programs may be desirable for manufactured dairy products and eggs. Programs for the eradication of disease among dairy cattle help to stabilize the industry. Farmers' committees can provide leadership, in connection with the conservation program, in other constructive movements, as for example in the elimination of low-producing cows.

NATIONAL CONSERVATION PROGRAM

The agricultural conservation program for 1938, with its national, State, county, and farm goals for soil-depleting crops and for soil-building crops and practices, represents a progressive development from the 1936 and 1937 programs under the Soil Conservation and Domestic Allotment Act. It follows the broad outlines already established and sets up definite objectives. These include an increase in soil-conserving crops and soil-building practices to further the primary aim of soil improvement. Goals for soil-depleting crops are fixed as a conservation measure and to assure an ample and balanced supply of food, feed, and fiber crops.

It is not a production-control program. In the absence of other legislation, normal weather conditions over several seasons again will result in

the accumulation of burdensome surpluses. This does not preclude the use of the present legislation to further conservation and help maintain the economic gains that agriculture has made since 1932. Farmers and farmer representatives from every State helped in drafting the programs, both in the main outlines and in the adaptation of the details to the needs of various regions.

The new program establishes a national goal for soil-depleting crops and a national objective for soil-building crops and practices. It subdivides the national goal into State, county, and individual farm goals. There are individual soil-depleting crop goals for cotton, corn, flue-cured, Burley, fire-cured and dark air-cured, and cigar-filler and binder tobaccos, peanuts, and rice. Corn goals for individual farms will be established only in certain areas in the Corn Belt. A soil-depleting crop goal for potatoes was established following a favorable referendum vote of the producers. Potato goals will apply only in designated commercial areas. Goals will not be established for potato producers growing 3 acres or less. Other crops included in the total soil-depleting crop goals will be classified together in the general soil-depleting crop goal.

Maximum Payment for Each Farm

A maximum payment will be calculated for each farm. Payment will be made for keeping within soil-depleting crop goals and for attaining soil-building goals, including the carrying out of desirable practices. If the soil-depleting crop goals are exceeded, or there is failure to reach the soil-building goal, the payment will be less than the maximum payment. In general, the 1938 crop classifications will follow those for the 1936 and 1937 agricultural conservation programs. In all regions payments will be divided between landlord and tenant in the proportion that they share in the principal crop, or in all crops and practices on the farm. Specific provisions applicable to the Great Plains region encourage the restoration to grass of land which should not have been plowed.

The A. A. A. regional organization for the administration of the program and provisions for local administration by county and State committees will correspond to those for 1937. Administrative expenses of all county agricultural conservation associations as in 1937 will be deducted from payments to farmers in their respective counties.

The purpose of establishing goals is to provide more definite objectives for 1938. Also, the goals should increase the program's efficiency by more directly encouraging better balanced farming. Assignment of individual goals should give each farmer a better concept of his part in the national conservation effort. Farmers will increase their soil-conserving acreage and soil-building practices as they have in the past, and will decrease their acreage in soil-depleting crops.

In actual operation the 1938 program should prove simpler and more effective than the two programs that preceded it. Each cooperating farmer, when goals for his farm have been established, will know just what he must do to comply with the plan, and how much he will receive for his compliance. Only one type of payment will be made. Full payment will be made only if the soil-depleting acreage does not exceed the goal, and if there is a sufficient acreage in soil-conserving crops and the required soil-

building practices to meet the soil-building goal. Payments will be decreased in cases of failure to reach the goals.

Factors in Calculating Payments

In arriving at the rates of payment the A. A. A. and the farmers' committees took the following factors into account: The number of acres in each goal; the farm value of the crops in each goal; the shift in acreage from the 10-year average necessary to reach each goal; and the farm value which these shifts represent based on 10-year average values. Hence, one-half the payment is based upon the conservation attained by reaching the goals, and one-half on the sacrifice involved. The 1938 goal for all soil-depleting crops is between 275 million and 290 million acres. This compares with the 1928–37 average of 305 million acres. The soil-building goal includes the normal acreage in soil-conserving crops and the increases resulting from the shifts in soil-depleting crops, in addition to practices such as liming, terracing, the restoration of land to native grasses, and the seeding of legumes and perennial grasses.

The total soil-depleting crop goal, including the general soil-depleting crop goal and the special soil-depleting crop goals for cotton, tobacco, corn, potatoes, peanuts, and rice has been divided among the States, the counties, and the individual farms. Within each State county goals have been established by the A. A. A. and the State agricultural conservation committee. County goals for cotton, tobacco, and rice have been established for each county where such crops are grown. County goals for corn, potatoes, and peanuts have been established for counties in the principal commercial producing areas.

County Committee Functions

In each county the county agricultural conservation committee establishes for each farm a total soil-depleting crop goal and any goal for an individual soil-depleting crop applicable to the farm. In establishing these individual goals the county committee considers the tillable acreage on a farm, the type of soil, the topography, the production facilities, the crop-rotation system, the acreage customarily grown on the farm, and the acreages of food and feed crops needed for home consumption.

County committees also establish soil-building goals for individual farms. These goals take into consideration the minimum requirements specified under the program, the acreage of new seedings required in 1938 to promote soil conservation, the application of limestone and fertilizer required for soil-conserving crops, and the improvement of pastures and the acreages on which terracing, contour listing, and other mechanical practices are needed to prevent wind and water erosion. They can be met by maintaining soil-conserving crops and by the use of other soil-building practices adapted to the needs of each State or county.

Under the 1937 program separate rates were established for the diversion of acreage from soil-depleting to soil-conserving crops and for the carrying out of each soil-building practice. The producer, when calculating his payment at the end of the crop year, applied these separate rates to each acre diverted and to each practice performed. In 1938 the maximum payment for each producer will be calculated at the beginning of the crop year and the attainment of the soil-depleting crop goal and the soil-building

goal will be set as conditions of full payment. Each producer will know what he must do for complete cooperation. This change should result in a greater degree of compliance and in consequence make the program more effective from the standpoint of soil conservation and economic use of the land.

FOREIGN TRADE

It is dangerous in economics to generalize from an insufficient number of facts, particularly when the subject is foreign trade. For example, the agricultural exports and imports of the United States have behaved in an exceptional manner in the last year or two, with the result that many people mistakenly believe principles formulated with regard to them in more normal times have no longer any application. But these principles still hold good.

Farm production in the United States from 1933 through 1936 dropped because of a number of causes, prominent among them being two tremendous droughts. The decline was many times greater than that contemplated in the original A. A. A. adjustments. As a result, our accumulated stocks for export dwindled, the export trade grew smaller and smaller, and it became necessary to augment the supply of certain products through imports.

In the fiscal year 1937 our total agricultural exports had a value of $732,839,000, or 4 percent less than in the fiscal year 1936. Because prices were higher, the reduction in volume amounted to 8 percent, and the total volume was the smallest in 60 years. On the other hand, our imports of agricultural products amounted in value to $1,538,324,000, or 35 percent more than in the fiscal year 1936.

This change in our foreign trade situation in farm products has been taken in some quarters to mean that our real problem is no longer one of disposing of agricultural surpluses in years of average or better-than-average conditions, but that the main need is to stop or regulate the inflow of foreign products.

Export Surplus Problem Continues

For the most part, however, the shifts that have taken place in our production since 1933 cannot be regarded as permanent. It seems improbable that droughts as severe as those of 1934 and 1936 will recur in the near future, though no one can tell. Moreover, for the time being we have no crop control, except such as may come about indirectly from the shift to soil-conserving crops under the Soil Conservation and Domestic Allotment Act. In most years our present agricultural area will produce large supplies for export, and the imports of competitive products will decline. Agriculture's foreign trade problem is not one of keeping out a trickle of imports, but of disposing of substantial surpluses. In short, the fundamental factors in our agricultural export trade are the same now as they were before the depression. This country on balance is an exporter rather than an importer of farm commodities, and needs a foreign-trade program correctly adjusted to that basic fact.

The agricultural imports of the fiscal year 1937, when our domestic supplies of certain products, notably food grains and feeds, were very low, were not more competitive than usual. Only slightly more than half the im-

ports were at all competitive with American products. With sugar omitted from the competitive list, because we always import sugar heavily, the competitive proportion of the imports drops to considerably less than half the total. To be precise it drops to 43 percent. Excluding sugar, the principal competitive imports in the fiscal year 1937 amounted in value to $620,000,000 as compared with $417,000,000 in 1936. They included quantities of feeds and fodder, purchased ultimately by farmers, and wheat necessary to supplement our reduced supplies of high-protein wheat. The inflow has since declined, and the production for export has increased, in line with this country's normal situation.

Debtor-Creditor Position

Our debtor-creditor position, and our general balance of payments bear upon our foreign trade. This is a creditor country. As such, it should be prepared to buy from abroad relatively more goods and services than it sells. Otherwise the countries in debt to it cannot make their payments. If we wish to increase our exports, we must increase our imports even more. Naturally, we should export the goods and services in the production of which we have an advantage, and should import the things in which other countries excel. Facilities for this profitable interchange have not yet been fully explored. The only alternatives are: (1) To make additional loans abroad, the effect of which action is simply to postpone the final reckoning; (2) to take gold in settlement of the export balance; or (3) to return to the position of a debtor country.

We tried the additional lending plan in the 1920's, and found that it did not work, when not backed up with a liberal import policy. The more we loaned, the more intractable became the problem of repayment. As for taking payment in gold, there seems to be gold enough for that to continue indefinitely. But what is the gain? Gold has limited uses, and we have more than enough already. More would not raise our standard of living; in fact, by raising the price level for everything, it might cause the standard to decline, particularly against groups that depend on foreign trade and world prices for their income. The third alternative, the return by some process to the position of a debtor country, would allow us to export without importing an equivalent; but that would mean paying interest charges indefinitely.

Entrance of Foreign Money

On paper our creditor position looks stronger than it actually is. There have been heavy defaults on foreign public and private debts to the United States. Moreover, much foreign capital has entered the country in the last few years, which constitutes a debt against us, and serves to offset our creditor position. Nevertheless, the latest information indicates that, with every allowance made for defaults declared or impending, and for the extent to which foreign capital has taken refuge in the United States, this country is still a net creditor on international account to the extent of approximately 5 billion dollars. Foreigners in 1936 paid us about $375,000,000 more interest and dividends than they received from us. It should be borne in mind, too, that much of the foreign capital that has come into the United States recently may not stay long. With stability restored in foreign currencies, or with signs of declining industrial activity

in the United States, it may flow back. Everything indicates, therefore, that we shall continue to be a creditor country.

In the decade of the twenties the increase in our loans to foreign countries made matters worse, for we had to receive interest on the new as well as the old debts. Short-term credits partially took care of the balance of international payments in the early years of the depression; but that method gave rise to a need for return payments more quickly than ever. After 1933 the importation of gold became an important means of effecting the adjustment; and as a result in 1936 our imports of goods and services exceeded our exports by an amount larger than the net payments of foreigners on their debts. The foreign gold that came in during the year represented mainly an inflow of capital, rather than payment for export items in the international balance of payments. Our current payments to foreigners increased. This was principally a result of the decline in our so-called favorable balance of trade. Exports from the United States exceeded imports in value by only $34,000,000 in 1936, as compared with $478,000,000 in 1934. For 1937 the imports may be larger than the exports.

Decline in Trade Balance Natural

There is nothing alarming in this decline in the so-called favorable balance of trade. Our creditor position warrants it. The reverse situation, with exports continuing greatly to exceed imports, would be far less satisfactory, because for reasons already noted it could not last, and might end in wholesale defaults once more. It is important, nevertheless, to look into the causes of the decline in the merchandise balance of trade, and to inquire whether it results from an increased willingness and ability to buy foreign goods, or merely from a relative decline in our exports. In the first case it will stimulate our trade generally; whereas in the second it will not.

The actual situation is a blend of the two tendencies. Economic recovery in this country, and also the conclusion of reciprocal trade agreements with many countries, have increased our ability and our desire to import foreign goods; imports have therefore expanded in harmony with the need to adjust our balance of international payments. However, the other factor, our temporarily diminished power to export certain commodities, has been important, too. About one-third of the decline in our favorable balance of merchandise trade between 1934 and 1936 resulted from the droughts that handicapped American agriculture in that period.

Adjustment at Reduced Trade Volume

Hence the closer adjustment that came about between the exports and the imports took place on the basis of a much reduced volume of farm exports. We did not import enough more foreign goods to give foreigners the means of buying our farm products on the scale that prevailed before the depression. When we have the same volume to export again, foreign countries will not be able to take it if the debtor-creditor relationship has not changed.

In our purchases of foreign services, as distinguished from our purchases of foreign goods, the most important single item is the expenditure of American tourists abroad. When an American travels in Europe, he buys and consumes European goods and services in Europe, and the effect on the

international balance of payments is the same as if he remained at home and bought the things here. Foreigners have that much more dollar exchange, with which if they choose they can buy American goods.

Tourist expenditures abroad have been rising, though last year they were still only about two-thirds of the average in the last half of the twenties. They may continue to increase; yet neither these nor other "invisible imports" can do away with the need for an increase in the importation of goods. From the standpoint of agriculture the need for a larger volume of imports, to serve as a basis for an increased exportation of agricultural commodities, is obvious. In the end international trade must balance; there can be no exports without equivalent imports, though the latter may include invisible items as well as tangible commodities.

Factory Goods in Export Trade

In the last few years industrial goods have constituted an increasing proportion of our exports. Agricultural products made up only 27 percent of the export trade in the fiscal year 1937, and that was the smallest proportion in the history of our foreign trade. It may be compared with 40 percent in the 10 years ended in 1932. Partly, the decline was the continuation of a trend that has been evident since the beginning of the century; in larger part, however, it may be ascribed to the drought-caused reduction in our export supplies. But even when foreigners buy industrial goods with the money they get for their shipments to the United States, our farmers benefit, through the increase that results in the buying power of industrial workers. When foreigners withdraw their investments here, they take out goods and services, and that means they employ American labor. Agriculture benefits directly and indirectly.

Outlook for Farm Exports

It may be assumed that our agricultural exports will again be substantial, as soon as the bins, granaries, and warehouses have been refilled. Much will depend, however, on world-trade barriers. These in turn will reflect tendencies toward self-sufficiency in the deficit countries, and the growth of competition in surplus countries. There is always an inclination for the deficit countries to buy where they can sell, and to favor agricultural sources that will take factory goods in exchange. This results in bilateral trade restrictions. Fortunately, world-trade barriers seem to be declining from the peak reached during the depression. Several countries have recently lowered their restrictions on the importation of wheat. Rising prices have made the restrictions unnecessary as a means of maintaining prices, and at the same time more burdensome to consumers. It is significant that the reductions have affected the central example of efforts toward self-sufficiency.

As yet, however, there is little evidence of a retreat by the importing countries from the principle of self-sufficiency. Germany, for example, is striving to maintain its present increased level of agricultural production, though with some indications of a perception that it cannot push self-sufficiency much farther. With political conditions disturbed, a radical change of agricultural policy is unlikely. There is a tendency toward the abandonment of artificial aids to exports by surplus countries; but this again is a result of the rise in world prices rather than of altered beliefs as

to the justification of such aids. World competition in agricultural commodities, with the exception of wheat, is increasing, notably in cotton, flue-cured tobacco, and fruit.

Reciprocal Trade Agreements

Trade agreements have been concluded by the United States with 16 foreign countries, which formerly took about one-fourth of our agricultural exports. Numerous valuable concessions have been obtained in reduced import restrictions on our agricultural products. These include reduced duties on lard, wheat flour, and various fruits and vegetables in Cuba; duty reductions by Canada on a long range of American fruits and vegetables; and reduced duties or larger import quotas on such products as fruits, tobacco, lard, and wheat by France, Switzerland, Belgium, and the Netherlands. Agreements have not as yet been reached with countries representing our leading markets, namely, the United Kingdom and Germany. However, substantial progress has been made in preliminary discussions with the Government of the United Kingdom.

Naturally, the United States has had to make concessions in return for those it has received. Some of our concessions have involved reductions in duties on agricultural products. They have been made only after careful consideration of the probable effects. Where it seemed possible that the reductions might cause a harmful increase in imports, they have been restricted to a specified quantity or to a seasonal basis. There is no evidence that any of the duty reductions have caused serious injury to our agricultural producers.

Agricultural products have not had to furnish a disproportionate amount of the bargaining power necessary to secure concessions in the reciprocal trade agreements. Ad valorem equivalents of the duties on manufactured goods have been reduced from around 42.4 percent, on the basis of 1934 trade, to 38.6 percent, or 9 percent, while the ad valorem equivalents of the duties on agricultural products have been reduced from 38.5 percent to 36.8 percent, or only 4 percent. Furthermore, nearly all the safeguards through quotas or seasonal arrangements have applied to agricultural products.

Significance of Trade Agreements

The principal significance of the trade-agreements program to American agriculture lies in certain broader aspects of the subject. (1) It represents a new technique in tariff making, which views the question of changes in import duties on particular products from the standpoint of the general welfare, and in the light of the importance of the industries affected and the proportion of imports to domestic production. It deals with import duties on particular products on their individual merits. This has rarely been done in our past. (2) The program provides a reasonable and practicable approach to the adjustment of our merchandise exports and imports to our creditor position. It facilitates a more liberal policy with respect to imports without jeopardizing the welfare of any important American industry. Finally, the program sets an example in breaking down unreasonable trade barriers, and makes for peace. Trade agreements cannot be

considered a cure-all for agricultural problems, but they can help to regain a part of our lost export market.

REQUIREMENTS IN LAND PLANNING

Through wise land planning this country with its low ratio of population to natural resources may escape the hardships that other countries have suffered. Consumers need not fear an actual land shortage; for the growth of population is slowing down, and much of the land available is still but little used. True, there is none to waste. All the good free or cheap land has been appropriated, and much land that was good formerly has been spoiled. Yet, with a rational allocation of land resources among the major uses, enough will be available to provide for our maximum probable population, and to maintain forests, wildlife refuges, and parks. But it is necessary to effect a better adjustment between soil-spending and soil-saving, and to put land to the right uses as dictated by physical, economic, and social conditions.

This is a problem with many aspects. Specialists formerly attacked it mainly from the physical standpoint, and chiefly considered what different lands might best produce. Certain areas were designated for crops, others for grazing, and still others for forests, wildlife, or recreation. After the depression of 1929, however, the land-use problem came to be conceived much more broadly from the human as well as from the physical standpoint, and with far more in it than merely the determination of crop possibilities. The land is for the people. Natural resources should promote human welfare, now as well as in the future, and this requires social as well as physical engineering. There are important economic requirements. Production, conservation, and the welfare of the land user go together. Separate them, and each breaks down. No single aspect of the land question can be dealt with independently. Soil conservation, for example, depends greatly on farm incomes, and tenure conditions influence both.

No More Frontiers

Until nearly the beginning of the twentieth century the process of land settlement in the United States was mainly from poor to fair lands, then to good lands, and then to excellent lands. This was logical, because for a long time the advantages of situation predominated over the advantages of fertility. Farmers could earn more, for the time being, on the relatively infertile lands near the Atlantic coast, than would have been possible on the richer but relatively inaccessible soils farther west. When the migration westward got well under way, however, it moved fast, and by 1900 or thereabouts practically all the good land had been brought into farms, settlement had begun to invade the remaining poorer lands, and there were no more frontiers.

Overnight the country woke up to the fact that it had a land problem, with mounting tenancy, a growing army of landless farm people, and a habit of soil neglect. As a heritage from the pioneer epoch, it had defective land-settlement methods, based on the false assumption that individual initiative in land use would always and inevitably promote both individual and social welfare. It had a tremendous problem of soil erosion, great areas of per-

sistent tax delinquency, a widening fringe of submarginal land in farms, and profound insecurity among large portions of the farm personnel.

Three Main Aims in Land Policy

Three fundamental purposes in land policy are complementary: (1) To maintain the income of farmers from efficient, properly adjusted production; (2) to improve the land-tenure system and give land operators more security in their jobs; and (3) to safeguard resources. They are inextricably interwoven. Farm incomes must be maintained, or tenure reform will be impossible; and without tenure reform it will be difficult to conserve the soil. In a given area the system of land use involves the whole pattern of climate, soil, topography, and social institutions. Improvement requires more than the application of any single formula. Attention given exclusively to any one of the major factors, such as the physical treatment of the land, or the relationship of land users to landlords and creditors, would accomplish little if offset by neglect of the other factors. Soil conservation needs the support of stable farm-commodity prices. Tenure reform requires a whole series of legal and institutional changes, as well as a farm-income level compatible with better conditions for the underprivileged. This whole problem is a social responsibility, which demands the integrated application of different programs.

Legal and political institutions restrict what the Nation may do in regulating land use. Landowners who want to mine their soil, without care for the future, have a right to do so under existing judicial interpretations of our basic law. It may be impossible, under the due process clause, for the Government to prohibit soil mining, or, except by persuasion or subsidy, to check unwise land settlement. Certain types of governmental activity in land planning seem practicable under our existing legal institutions, and other types cannot be developed without legal changes.

Our legal institutions affect the answers we can make to the general question, What should be the relationship between governmental activity and private initiative in dealing with the land problem? Land problems can be dealt with in a certain way if we presuppose no change in property rights and in other ways if we interpret more broadly the sphere of public obligation. Maintenance of the old laissez-faire tradition will block effective action. Greater public regulation, while modifying the right of the individual to abuse the land, should not impair the value of his property rights; indeed, it may enhance them.

Influence of Farm-Land Values

Farm valuations influence land planning. This Department made a study which showed that the farm real estate market tends to assume that the past rate of increase in farm earning power forecasts the future rate. The result, where farm-land values have risen in the past, is to incorporate a speculative element in present valuations, which the future growth of earning power may fail to justify. Land booms and their aftermath are the familiar results of this error. In Iowa and other Midwest States prior to 1920 the average level of farm valuations was so high that the current earnings gave a return of only 3 percent on the investment. Farmers were borrowing at 6 percent to earn 3. In the ensuing depression tenancy

increased seriously. Less extravagant estimates of farm earning power would minimize such difficulties.

But operation and ownership in agriculture tend to become separated also through the natural competition of an increasing population for a limited land supply. With all good land occupied, no land is cheap. Those who want land bid up the price until land charges absorb the greater part of the production. This may happen even if farm earning power increases, though in regions where values have long been stabilized, as for example in the Northeastern States, the speculative influence has less play. Therefore, it is necessary to consider not only the return upon the investment but the labor return in agriculture. Present agricultural policies may substantially increase gross farm incomes; but if the increase merely supports excessive farm valuations, and builds up a great structure of debt, operating farmers will be little better off. Moreover, public land planning will be more difficult, particularly the acquisition of land by public agencies. Thus care for labor income in farming must be part of a rational land policy.

Methods of Private Land Use

Outstanding in our national land policy is concern over the methods of private land use. When this country broke away from the economic restrictions of British mercantilism in the eighteenth century, it went to the opposite extreme, and placed the ownership of land practically on the same basis as the ownership of personal property. Anyone who owned land "in fee simple absolute" could use it productively or could waste it, without regard to the social consequences.

Possibly no other nation or people has gone as far as this one in throwing away all safeguards in the use of land. Even the Indians practiced conservation before the white man came, and restricted the exploitation of wildlife and forests. Our tenure system has helped to ruin millions of acres of fertile soil, to cause speculative land booms, to create tenancy wholesale, and to accentuate the ups and downs of production. The American people now realize that the ownership of land should not include the right to destroy it, or to use it against the interests of the community. There is an intrinsic public interest in the use of land, whether it be in public or in private ownership. This principle is the cornerstone of our national land policy.

There is an important social interest in so-called submarginal land. Millions of acres have been settled without knowledge of their physical and economic possibilities, and additional large areas have been ruined. The report of the President's Great Plains Committee showed the inadequate and variable incomes, the excessive dependency, and the destruction of soil resources that result in that region from attempts to crop farm land suited primarily to grazing. Serious problems of land utilization exist in many regions. Competition prevents many owners from treating the land properly. The result is widespread rural distress. Families on poor land have had to demand cash relief, emergency loans, and various hidden subsidies in public provision for schools and roads. In some areas millions have been spent in vain for the rehabilitation of such families. Subsidies and unproductive expenditures cannot continue, and better expedients exist. There is no simple, mechanical remedy, such as wholesale resettlement.

Insecurity of Tenants

Tenancy involves serious difficulties. It is not so much tenancy itself, however, as the insecurity that goes with tenancy, that demands attention. This is necessary in the general interest, as well as in the interest of the tenants themselves. Tenancy under the prevailing tenure conditions may damage the land irretrievably and block corrective action. Moreover, it handicaps the movement for rational crop adjustment. Tenants of necessity concentrate on the production of soil-depleting cash crops like cotton, wheat, corn, and tobacco. With their short leases, they have little interest in crop adjustments that run over a period of years.

The main defects of our tenancy system result from our excessive development of ownership in fee simple, which makes the rights of ownership paramount to all other rights. Tenant operators seldom have the safeguards necessary for their personal welfare or for the conservation of the soil. Other countries require owners to compensate their farm tenants for improvements that the latter may make on the land and discourage the arbitrary ejection of tenants without due notice or proper cause. The United States might well do likewise. Where tenants occupy poor land, with no sure lease, and no capital to farm the place, they sink inevitably to penury and neglect the soil.

Many farmers have only a transitory and insecure interest in the farms they cultivate. They have no permanent interest either in a particular farm or in a particular community. Tenants and sharecroppers number about 2,565,000 persons and represent about 42 percent of all our farmers. Most of them have 1-year leases, and little or no assurance that the leases will be renewed at the end of the crop year. One-third of the tenants change farms every year. Even those who remain on the same farm seldom know in advance that their leases will be renewed. Farm tenancy is very prevalent in the corn, wheat, cotton, and tobacco areas. In many areas of the South tenants represent more than 80 percent of all the farmers. Throughout large areas of the country more than 40 percent of the farmers are tenants. Approximately 41 percent of all tenant farmers in the United States are in the Cotton Belt. In the Corn and Wheat Belts about 44 percent of the farmers are tenants. Tenancy is lowest in the dairying, general farming, and grazing regions.

Many Owner Farmers Insecure

Many owner farmers have an insecure relationship to the land. Some are so heavily in debt that their ownership is nominal. An owner with a heavy mortgage has a more secure relationship to the land than a tenant with a 1-year lease. Nevertheless, the interest and principal payments on his mortgage are a fixed amount each year, whereas his income is variable, and depends both on production and on prices. Consequently, he is often in a very precarious position. Other owners have farms too small or too poor to afford an adequate living. They are insecure because of an ill-adjusted relationship to the land. Their equity in the land is continually vanishing because their holdings are too small or too infertile to pay operating costs and living expenses. About 1,500,000 full owner farmers are free of mortgage debt. Others have a moderate debt load which does not

threaten their security. But insecurity haunts thousands of agricultural people—owners, tenants, and hired laborers. It is a problem of national concern.

Forest lands offer a striking example of the American record of land misuse. These lands constitute almost one-third of the area of the continental United States, and three-quarters of them have long been in private ownership. Four-fifths of all the most valuable or commercial forest lands are privately owned. On these lands fires have burned more than 41 million acres annually; ax and fire together have devastated or crippled close to 74 million acres. Forest empires have been destroyed, sawmills shut down, workers scattered, and soils eroded. All the uses of the forests, for timber, soil and moisture conservation, wildlife, recreation, and grazing could be improved both for current production and for conservation. Forests are a source of employment noncompetitive with agriculture; they are also a source of supplementary income for farm people.

Forest Care Creates Income

Development of the national forests for sustained yields, progress in afforestation and reforestation, and the return of submarginal lands to forests creates important social values. What forests mean to agriculture in the creation of part-time employment, in the protection of land and water resources, and in the relation of forests to climate and rainfall deserves more attention. We solve only half the economic problem when we stop producing surpluses. It is equally important to start producing something else, and forestry offers an excellent opportunity. Besides producing timber, forestry can conserve soil and water and wildlife, and can furnish extensive recreation facilities. It provides considerable employment and increases the value of our natural resources. In proper forest uses, certain areas may provide more jobs and produce more income than they could in any other way. There are three principal requirements: (1) The acquisition of forest land by public agencies; (2) the restoration of this land to profitable timber production through fire prevention, replanting, and judicious cutting; and (3) extension of adequate fire protection to more private forest lands, with provision on the same lands for future crops.

Control of the range is necessary to check overgrazing, to restore the range vegetation, and to prevent further unwise extensions of crop growing in range areas. Methods of improving the range cover must be developed, conflicts between public and private interests in the use of the range must be resolved, and legislation must be devised to coordinate Federal with State action in range-land planning. Existing legislation makes only a start in this task. Grazing on the open range, from the time when its cheap, abundant forage permitted the rapid development of a prosperous livestock industry, to the present time with its growing difficulties in reduced range carrying capacity, its erosion, and its extensive diversion of range land to crop production, is a story of range deterioration. Controlled grazing, sustained-yield management, reseeding with suitable grasses, and erosion control are necessary, even to interests that short-sightedly oppose such action. Many range farms could be put back to grass. There are economic as well as physical problems to solve; but the task may not be shirked. It is imperative to prevent the further improvident homesteading of range land and to correct some of the results of past mistakes.

Coordination of Land Activities

Land policy may seek to correct maladjustments in particular areas of submarginal farming, of extensive tax delinquency, of overgrazing, of excessive erosion, or of reckless forest destruction. But it does not suffice to do that alone. Such problem areas are not isolated sore spots. They are outcroppings of more general distress, or symptoms of disorder in the whole agricultural system. Bailing them out accomplishes nothing if the trouble will run into them again from the main pool or collect somewhere else. In dealing with local maladies we must treat the general maladjustments from which they come, just as in city slum removal it is necessary to increase the incomes of the slum population to prevent the slums from returning. The pathology of problem areas cannot be localized, and attempts to cure it independently of agricultural adjustment in general may only shift it about, without lessening the total distress at all.

Moreover, the task requires the combined action of different technical agencies. It may involve farm management, credit reform, erosion control, forestry, and wildlife conservation—in short, an application of physics, agronomy, and biology, in combination with the social sciences. It will require also a coordination of Federal, State, and local activities. Merely to coordinate the work on a basis partly functional and partly regional would overemphasize the special techniques and throw excessive responsibility on foresters, soil specialists, and agronomists as such. Besides breaking down the land problem for convenience in attacking particular evils, it is necessary also to unify it for action of a more general character.

LAND PROGRAMS UNDER WAY

In promoting the various aspects of the national land policy, the Federal Government does not and should not accept the whole responsibility. Farmers have a part to play. Through their national organizations, and through the State and county committees created to assist in the administration of the soil-conservation programs, they are fulfilling this responsibility better today than ever before.

State and local agencies have opportunities and responsibilities likewise. State legislation covers the field of land-tenure relationships, zoning, taxation, tax delinquency, and other matters vital in land planning. It may provide authority, as many States have already done, for State soil conservation districts, and may facilitate cooperation with Federal agencies in flood control, forest-fire prevention, wildlife conservation, and other conservational activities. Nevertheless, the Federal Government has heavy responsibilities in land planning, some of them long rooted in the established national agricultural policy, and others the outgrowth of recent legislation. It will be useful to glance at the major ones.

One of the principal Federal activities in land-use planning finds expression through the Agricultural Adjustment Administration, which administers a Nation-wide program of soil conservation through benefit payments. Adjustment measures encouraged soil conservation under the A. A. A. programs from 1933–35. When these gave place to programs under the Soil Conservation and Domestic Allotment Act of 1936, soil conservation became a primary goal. It has taken its place in agricultural adjustment

as a foundation element. As noted elsewhere in this report, flood control through land treatment is a responsibility of the Department of Agriculture under the Omnibus Flood Control Act of 1936. Various forest-purchase acts, along with the national-forest policy, make this Department potent in safeguarding forest resources. Through the Bureau of Biological Survey it acquires land for wildlife refuges and contributes in this way to the conservation not only of wild birds and mammals but of soil and water. The Soil Conservation Service carries on research, demonstration work, and actual erosion control in cooperation with land occupiers.

Land-Use Aspects of A. A. A. Programs

After the crisis of 1929 agricultural thought and action turned away from the land question for a time, in order to deal with the more urgent problem of the surplus. With supplies of the major crops vastly in excess of market requirements, the first task was to reduce them. From 1933 to about the end of 1935, the farmers gave principal attention to that, and with Federal help tried to effect the necessary crop adjustments. Some of the things done, however, took small account of good land-use principles. Flat percentage cuts in acreage affected good and poor land alike and prevented desirable crop shifts. This was inevitable in the drive for quick results. But it revived interest in the land question.

So as to avoid a conflict between the adjustment quotas on the one hand and good farm management on the other, the A. A. A. began to plan long-time adjustments, with good land use, balanced farming, and soil conservation as the basis. It saw that crop adjustment and wise land planning are aspects of the same problem, the wider ramifications of which touch the relationship of the farmer to the land, and also the relationship of agriculture to the entire economic system. Other branches of the Federal Government tackled different phases of land policy, and land reform progressed. Public opinion realized the need for action; public agencies obtained authority to promote it.

Soil conservation on the farms has been instituted on a national scale; forest purchases have been enlarged; legislation, both Federal and State, has provided means for bringing great areas of grassland, forest land, and eroding land generally under unified conservational control; further settlement of the public domain has been suspended pending determination of the uses to which the land can best be put; Federal funds have been appropriated to aid tenants in becoming farm owners; flood control has been recognized in Federal legislation as a problem in land treatment as well as in downstream engineering; and a beginning has been made in the withdrawal from agriculture, and the development for other uses, of lands that should not be farmed.

Some of the conservational activities have a long history; forest conservation, for example, attracted national attention about 35 years ago. Other features of the national land program reflect new conceptions of the bearing that land-use practices have on the general welfare. Taken together, the old and the new features constitute a many-sided attack on practices that destroy resources, create rural poverty, and lower the Nation's standard of living.

Government Land Buying

Government land buying is an essential phase of the national land policy, and may have an influence beyond the areas actually purchased. It can divert some poor farm land to grass, forest, or wildlife uses, and can acquire additional areas for parks. This procedure, often without costing very much money, may change the land-use pattern throughout large districts. For example, certain areas in the West formerly supported large groups on virtually a subsistence-farming basis. Commercial grazing entered, practically monopolized the range, and left the former inhabitants without a livelihood. They required relief. Subsequently, the big graziers demanded assistance, too. With a reorganization of the land-use pattern, and the acquisition of certain key areas by public agencies, it should be possible to enable the former population to live without an annual Federal dole.

Nevertheless, the purchase of land by Government agencies can be but a part of the national land policy, because most of our land resources must remain in private uses of one kind or another. Occupants, unless means can be found to dissuade them, may continue to waste and destroy the soil. Droughts and dust storms in the West and flooded countrysides in the East have demonstrated that private land-use methods are of public concern, and focused attention on the necessity of influencing them through social guidance. Along with the public acquisition of land unsuited to farming should go a well-developed program of land conservation and utilization, with proper emphasis on reforestation, flood control, the prevention of soil erosion, the conservation of surface and subsurface moisture, and the correction of land-use maladjustments generally.

Land-use-readjustment programs have been under way for several years in the Appalachian and Ozark highlands, in the cut-over regions of the Lake States, the Gulf coast, and the Pacific Northwest, and in problem areas elsewhere. These programs contemplate the acquisition of some 9,100,000 acres of land that is unsuited to farming. It will be diverted to other uses, such as forestry, grazing, wildlife, recreation, watershed protection, and flood control.

New Type of Federal Land Acquisition

This is a new type of Federal land acquisition. The Federal Government has long bought land for governmental purposes, and for the establishment of national forests, national parks, and game refuges. In this older type of land acquisition, the object is to establish some particular desirable public use, regardless of what the land has been used for heretofore. But none of these purchase programs was directed specifically toward the retirement of farm land not suitable for cultivation. In the newer programs, the major purpose is to change undesirable patterns of land occupancy and consequent agricultural land use into a beneficial public use or combination of uses, and to make the land a productive public asset. What the land will be turned to next is of secondary concern, provided it serves a desirable public end. In short, the object is to correct past errors.

The National Resources Board has estimated that some 460,000 farms should be retired from agricultural use. These farms are largely on poor land in areas of social and economic maladjustment, often in what may be

called rural slums. Farm income there is low, credit expensive, the housing poor, and the people ill fed. Educational facilities are meager. Other governmental services are lacking or provided at excessive expense by the general public. There is a description of some maladjusted areas, and an analysis of the maladjustments, in part VI of the Supplementary Report of the Land Planning Committee to the National Resources Board. The Great Plains region, including the "dust bowl", has more than 100,000 farms that should be turned over primarily to grazing.

On land now optioned or purchased by the Farm Security Administration, prior to the passage of the Bankhead-Jones Act, there were initially 13,803 families. This number includes 574 families that will remain on the project areas, some of them as project employees. Others are elderly people who may remain in their homes for the rest of their lives. Approximately 5,000 families have moved with or without aid to other farms, or have taken up other occupations. Every consideration will be given to assisting families still on the projects, with the exception of the 574 just mentioned, to find new opportunities elsewhere. Families living near the project areas or on lands within them which are not being acquired, will reap certain benefits from the land purchase and developmental programs.

In readjusting the uses of the submarginal farm land in the acquisition program, the Office of Indian Affairs will use 1,227,213 acres; the Bureau of Biological Survey will use 722,050 acres for migratory waterfowl refuges, and 6,749,967 acres will be devoted to forestry, grazing, and miscellaneous objectives. The remaining 401,472 acres will be developed for recreational purposes by the National Park Service. Land-use adjustment projects comprise 78 percent of the present program (or 6,749,967 acres). It is estimated that 21 percent of this area will be devoted entirely to forestry; 58 percent to grazing; 7 percent to a combination of forestry and grazing; 5 percent to wildlife; and the remaining 9 percent to miscellaneous uses.

The Bankhead-Jones Farm Tenant Act

Congress passed the Bankhead-Jones Farm Tenant Act on July 22, 1937, to relieve and progressively eliminate the worst forms of tenancy, and also to promote rural rehabilitation, proper land utilization, and the retirement from agriculture of land that is submarginal for farming. Three titles of the act establish tenancy, rural rehabilitation, and submarginal land-purchase programs, and a fourth title deals with its administration. The measure entrusts large new responsibilities to this Department.

In title I it directs the Secretary of Agriculture to conduct a farm-tenancy program and for that purpose authorizes appropriations in the amounts of $10,000,000 for the year 1937–38, $25,000,000 for the following year, and $50,000,000 for each year thereafter. With this money the Secretary may make loans to farm tenants for the purchase of individual farms. Local county committees will select the applications. Loans may be equal to the full value of the farms and may run for a 40-year period at 3-percent interest.

There is a provision in the act that the Secretary shall not be legally obligated to relinquish his interest in any farm purchased under the program for a period of 5 years from the date on which the loan is made. Furthermore, the Secretary may supervise farming operations on the purchased farm throughout the life of the loan.

Such a program cannot lift any large proportion of our tenant farmers to the ownership status. Two out of every five farmers in the United States are tenants today, as compared with only one in four in 1880. Farm tenancy increased at the rate of 33,465 farms a year during the period 1880 to 1935. Assuming that this represents a normal rate of increase, and assuming that on the average an investment of $4,000 would suffice to supply each of these tenants with land, buildings, and equipment necessary to make him economically independent, it would take an annual appropriation by the Federal Government of $133,860,000 a year merely to take care of the annual increase in tenancy. This would make no reduction whatever in the number of tenant farms already in operation. Nevertheless, the new program, modest though it is, will begin to lift worthy tenants up the tenure ladder, and at the same time will promote better farming and better care of the soil. As the experiment proceeds, it should be possible to extend and improve it.

Not all farm tenants need to be converted into owners in order to give them the necessary security. Cheap land in itself may not be the answer. This country had plenty in the past, and gave it away freely under the homestead laws; yet throughout large areas today there are more tenants than owners, and the tenants are very insecure. It is well to aid tenants in becoming owners as funds and opportunities permit; but the problem of giving more security to the remaining tenants must be dealt with in other ways. Land buying, indeed, sometimes causes speculation, excessive debt, and foreclosure, the end result of which is more tenancy. We need a better farm-tenant system and better methods of land leasing. This is largely a problem for the State governments; State legislation is necessary to give tenants the right to renew their leases and to give them compensation for the improvements they make on the land.

Act Contemplates Broad Program

The second title of the Bankhead-Jones Act provides for a rural rehabilitation program of loans and guidance, similar to the one formerly conducted by the Resettlement Administration. There is no appropriation for this rehabilitation, but the President may allot, out of appropriations made for relief or work relief, any amounts which he may determine to be necessary. Rural rehabilitation loans bear interest at low rates and may not be made for more than 5 years. At maturity, however, they may be renewed.

Retirement of submarginal land is the heading of title III of the Bankhead-Jones Act, but the title provides for much more than that. It directs the Secretary of Agriculture to develop a general program of land conservation and land utilization, with the retirement of lands unsuited to agriculture as one of the principal features. For all its purposes under this title the act authorizes an appropriation of $10,000,000 for the fiscal year 1938, and $20,000,000 for each of the 2 succeeding fiscal years. It directs the Secretary to cooperate with Federal, State, Territorial, and other public agencies in land-use planning, and to make the necessary surveys and investigations. All the principal aspects of good land utilization, including submarginal land retirement, erosion control, forestry, land treatment for flood control, and the conservation of the soil, will be directly or indirectly promoted by title III of the Bankhead-Jones Farm Tenant Act.

Water-Utilization Plan

Wastage and inadequate utilization of water resources of farming, grazing, and forest lands is common in the arid and semiarid areas. It results partly from the fact that facilities are inadequate for storing water. This wastage, which destroys resources and contributes to crop failures, can be measurably prevented, and Congress at the last session passed an act (Public, No. 399, 75th Cong., approved Aug. 28, 1937) to promote that end. The act declares it to be the policy of Congress to assist in providing facilities for water storage and utilization in the arid and semiarid areas, and authorizes the Secretary of Agriculture to undertake action programs in this field.

These programs will deal with the construction and maintenance of ponds, reservoirs, wells, check dams, pumping installations, and other facilities for storing and utilizing water. The Secretary may obtain options on, and may acquire necessary lands, or rights or interests therein, or rights to the use of water. As a condition to the extension of benefits under the act to any lands not owned or controlled by the United States, the Secretary may require the enactment of State and local laws to provide for soil-conserving land uses and practices, and for the storage, conservation, and equitable utilization of waters. The statute recognizes that the proper planning and location of water facilities is indispensable to the proper use of lands. Therefore, the administration of this bill will need to be coordinated with the administration of title III of the Bankhead-Jones Farm Tenant Act, which calls for a program of land conservation and land utilization. It is feasible, and also highly desirable, to integrate these two comprehensive programs.

State Legislation on Land Problems

The States are showing interest in directed land-use readjustments within their borders, and are adopting necessary legislation. Six States have enabling acts authorizing some or all of their counties to zone rural land. Rural zoning bills have been introduced into the legislatures of several additional States. Many States are giving attention to the improvement of tax-reversion procedure, and to provisions for the classification of tax-delinquent lands prior to their redisposal. Twenty-two States have enacted soil conservation districts laws, permitting local communities to form districts for the control of cultural methods to reduce soil erosion. Three States have enacted laws to improve the condition of tenants, and six other States have considered similar legislation.

Particularly important is the problem of tax-delinquent lands. Because of unpaid taxes, the States have taken title of a sort to millions of acres of land, and created a constantly growing public domain. Usually the States attempt to turn this land back into private ownership; they do not reflect that if the former owners had considered the land worth the taxes, they would not have let it become tax-delinquent. Some States have sold land for agriculture that was definitely not suited for farming. Land turned back to the States in this manner is apt to be of questionable value for commercial use, but could be profitably developed in forest, wildlife, or recreation uses.

Persistent tax delinquency, however, is not confined to large blocks of land in very poor sections. It may be scattered through areas of valuable land; and on the other hand some land in poor sections will remain above the delinquency level. Tax delinquency sometimes results from the overcapitalization of the land, or from excessive or maladjusted tax burdens. Its existence is not in itself a proof that the land involved should be transferred to public ownership; but it is always an evidence that something is wrong. Here again no blanket remedy can be proposed. Particular areas have particular problems, and proper handling of them will usually involve many different techniques.

Interrelated Aspects of Government Programs

These diverse land programs necessarily require coordination. It is obvious, for example, that resettlement or rehabilitation programs must not conflict with national objectives in erosion control or reforestation. Distressed farmers may request loans to keep on farming land that should not be farmed; it is much better to deal with their problem in some other way. Similarly, A. A. A. payments for specific land-use practices should harmonize, not only with erosion-control and flood-control projects in particular watersheds, but with regional and national objectives in crop production. In the northern Great Plains, where continued drought is making a new dust bowl, good land use depends on many things, some of them more or less within the control of individual farmers, and others dependent on Federal and State action. Farmers may plant more grass and shift their crop systems. But it may be necessary also for the Government to purchase some submarginal land in the area, under title III of the Farm Tenant Act. Perhaps work under the Farm Forestry Act would be required. Payments under the Soil Conservation and Domestic Allotment Act may encourage wise cropping. The Soil Conservation Service may give technical help to farmers who must strip-crop, contour-plow, and do other things to check wind erosion.

Good coordination of all these projects in concept and in action, so that each fits in properly with the others, will greatly increase the beneficial effect. There is need also for coordination among Federal, State, and local authorities. For example, the Soil Conservation Act authorized the Secretary of Agriculture, as a condition to the extension of benefits under that measure to lands in any State, to require the enactment of the State laws for the prevention of soil erosion, and in conformity with this provision, the Department has drafted a standard State soil conservation districts law, which many States have adopted without substantial change. With proper coordination of Federal and State objectives and procedures this legislation will facilitate collective good land use. There is excellent Federal-State cooperation in agricultural research and education, and it should not be difficult to develop corresponding cooperation in action programs affecting land utilization. The Department and the agricultural colleges have committees at work on this problem.

Coordination of Land-Use Planning

These are just a few of the coordination requirements of a sound land-use policy. Land-planning work in the Department must be coordinated also with that of other Federal agencies. As an aid to the coordination task in general, the Department has appointed a coordinator of land-use planning, who will represent the Secretary in coordinating land programs within the Department, and serve as executive officer of the land policy committee and as chairman of the flood control advisory committee.

All the purposes of the national agricultural policy, which boil down to parity farm incomes, security for the rural population, and the conservation of resources, depend for their success on a correct emphasis and proportionality among the various land programs; in short, on good coordination.

Indeed, everything the Department does affects land use in one way or another. Disease control, for example, may necessitate crop shifts that will affect the land-use pattern. Marketing agreements and commodity grading and standardization may exert an influence, through their effect on the production and distribution of crops. The Department has always endeavored to avoid duplication of effort in carrying on its manifold jobs, and to eliminate conflicts of purpose. But the large new responsibilities imposed on it by the legislation of recent years make the task more difficult and necessitate the creation of special coordination machinery.

LAND TREATMENT FOR FLOOD CONTROL

The Omnibus Flood Control Act of 1936 authorizes a coordinated land and water program for flood control. It declares, (1) that flood control on navigable waters or their tributaries is a proper Federal activity in cooperation with the States and their political subdivisions, and (2) that flood control requires not only the improvement of rivers and other waterways but also the treatment of lands that shed water.

Congress specified in the act that responsibility for the improvement of rivers and waterways shall rest with the War Department; and that investigations and measures for run-off and water-flow retardation, and for the prevention of soil erosion on watersheds, shall be under the jurisdiction of the Department of Agriculture, except as may be otherwise provided by acts of Congress.

The act takes definite steps toward carrying out the declared policy. It directs the Secretary of War to proceed, as soon as funds are available, to carry out a number of specified control operations, for some of which the War Department has already completed investigations. It also authorizes the Secretary of War and the Secretary of Agriculture to make preliminary examinations and surveys in 222 specified areas, as a basis for potential flood-control operations. Examinations and surveys carried on by the War Department will deal with the waterways, while those carried on by the Department of Agriculture will deal with the land and small streams within the watersheds. In this work, the two Departments will cooperate closely.

In many respects the increased responsibility for flood control now placed upon the Departments of War and Agriculture is the capstone of a

long list of responsibilities previously delegated to them by Congress. For more than 50 years the Army engineers have been at work on the improvement and control of the major rivers and waterways of the United States. Similarly, the Department of Agriculture, in cooperation with State colleges of agriculture and experiment stations, has for nearly 75 years been conducting research, the results of which form the scientific foundation of proper land use and improvement. During the past 30 years the Department of Agriculture has had responsibility for the administration of soil and moisture conservation programs on an ever-widening front.

Research and experience on a large scale in the Department of Agriculture have demonstrated that watershed treatment to conserve the soil and retard the water run-off can make a fourfold contribution to flood control. It can (1) reduce sedimentation in reservoirs; (2) minimize the silting of stream channels; (3) decrease the frequency of minor floods; and (4) diminish the crests of major floods.

Moreover, it conserves the soil, an obvious advantage aside from flood control. Naturally, the relative value of proper land use to flood control will vary in different watersheds and at different times, and detailed investigations will be necessary to determine its full effectiveness in specific localities. As a rule, however, proper land-use measures are highly effective. The principal methods include the regrassing and reforesting of land unfit for cultivation, forest protection, the control of grazing, the protection of cultivated land with strip cropping, contour cultivation, terracing, and proper crop rotations. Such methods anchor the soil, and protected soil detains water. Erosion control is the land phase of flood control.

Nature's Lessons in Flood Control

Nature shows what should be done to control soil and water in the uplands where the floods begin. Over practically every foot of land under forest or natural grass, nature throws an interlacing system of tiny dams. A dead leaf, a blade of grass, a root tangle can stop a raindrop from running away and lead it into the soil. Wise land use is simply an adaptation of nature's methods. Instead of inviting erosion by leaving fields smooth and bare, it will turn the earth itself and the plants into impediments to the run-off. By plowing and cultivating around the hill, instead of up and down the hill, the farmer may transfrom each furrow and each harrow scratch into a small dam or terrace. On the steeper slopes he will need more elaborate dams, and he may need to stop growing the crops that promote erosion seriously. But whether the methods be simple or elaborate, the principle is the same—to slow down the running water, and to keep the soil where it may serve as a reservoir.

Good pastures shed little water and lose little soil. Trees put a roof above the soil, and cover it with a protecting carpet. Strip cropping, whereby thick-growing crops alternate with clean-tilled crops in bands around the contours of the land, retards the loss of soil and water. Terraces may serve as dams across cultivated fields, and check dams in gullies will slow down the water and diminish its cutting power. Whatever its use, whatever its ownership, whatever its economic status, sloping land is all of one kind in its relation to flood control; and most of our farm land, not to speak of our forest land, is sloping. In the last analysis the problem of flood control is the problem of retarding the movement of the water down the slopes.

Watershed treatment includes engineering features as well as changes in production. Upstream engineering includes terracing, strip cropping, and contour furrowing on slopes, as well as small dams and other installations for regulating the water flow. Engineering surveys will therefore be necessary by the Department of Agriculture as well as by the War Department. Naturally, however, the Department of Agriculture will not deal with the major structures and devices for flood control. These are the responsibility of the Army engineers. The agricultural engineering studies will be confined strictly to the upstream and land aspects of the problem.

As a basis for recommendations to Congress, surveys will analyze the expected benefits. These will be based largely on the slowing down of run-off and on the control of erosion. Estimates will be furnished as to the probable conservation of soil and water, as to the probable reduction in sedimentation, as to the probable benefit to the public health, as to the protection watershed flood-control work will give to wildlife, and as to the economic advantages which may reasonably be expected both locally and nationally. Public benefits will be considered separately from those that will accrue to private individuals.

THE SOIL CONSERVATION SERVICE

The most uncertain element in land-use planning, and one that deeply influences the social and economic structure of agriculture, is the physical deterioration of good land now under cultivation. Our soil resources cannot be considered a constant factor in land-use planning until the forces that damage the soil are brought measurably under control.

Soil can be farmed so as to preserve almost indefinitely its physical structure and productive capacity. The manner of its use, and particularly the manner of its preservation, are of paramount concern to the Nation, as well as to agriculture. It is the purpose of the soil-conservation policy of the Department to restrict as much as possible the destructive forces that deplete and impoverish a large aggregate area annually. The Department aims to bring as much land as possible under continuous conservation treatment.

Primary responsibility for providing the necessary active leadership and technical guidance rests with the Soil Conservation Service. This agency conducts exhaustive research into various aspects of the soil-erosion problem, develops practical soil-conserving measures, and assists individual farmers in applying such measures to the land. But the physical forces that cause soil wastage are not limited to farms or parts of farms. They operate not merely in artificially bounded areas, but in larger areas with natural boundaries and natural characteristics of soil, slope, and climate. Intensive treatment of isolated farms or groups of farms in relatively small demonstration areas cannot suffice; for soil-conservation policy should embrace all the land in need of protection.

Effective soil conservation requires the coordinate treatment of all the lands in natural areas of similar soil, slope, climate, and types of farming. Because this involves property rights, the prerogatives of State and local governments, and numerous social and economic considerations, it requires the coordinate mobilization of Federal, State, and local efforts. Accordingly, the Soil Conservation Service is broadening its program, and cooperating with groups of land occupiers legally organized under State law, in

associations that represent all the land within complete watersheds or in other natural land-use areas.

State Laws for Conservation Districts

It is obvious that soil conservation cannot be accomplished adequately by the application of a few unrelated measures to the lands of a few individual farmers. Furthermore, the demonstration programs of the Soil Conservation Service cannot spread soil conservation principles and practices rapidly enough to keep pace with requirements in land-use planning. In recognition of these facts the legislatures of 22 States have passed soil conservation districts laws, which encourage and pave the way for more widespread and more intensive participation by farmers and other land occupiers in soil conservation efforts. For the most part, these laws follow the general principles of a standard State soil conservation districts law prepared in the Department of Agriculture at the request of numerous public and private agencies interested in soil conservation.

The standard act provides for the establishment of a State soil conservation committee and supplies a procedure for the creation of soil conservation districts, as governmental subdivisions of the State.

Generally, the legislation authorizes the exercise of two types of powers: (1) The power to establish and administer erosion-control projects and preventive measures, including assistance to farmers in carrying on erosion-control work; and (2) the power to prescribe land-use regulations in the interests of the prevention and control of erosion. Such regulations must first be submitted to a local referendum vote. When approved they have the force of law within the district.

This is a democratic approach, which puts the primary responsibility and initiative on those who work the land. It opens the way for closer cooperation between the individual farmers, the State governments, and the Federal Government in land-use practices calculated to advance both the interests of the individual farmer and the interest of society.

As soil-conservation districts are formed in the various States, the Soil Conservation Service in cooperation with State agencies will develop a broad program of leadership, technical advice, and assistance. This may largely supersede the present intensive treatment of relatively small areas in demonstration projects. Primary responsibility for the defense of the soil will then rest with the legally constituted conservation districts. Vested with legal power to make land-use regulations subject to approval by a majority vote, and likewise with power to petition the State courts for the enforcement of such regulations, the districts will be able to go beyond the limitations that necessarily hamper the Federal Government. They will exercise a basic democratic principle not greatly different from that which underlies urban zoning.

Surveys and Methods in Soil Defense

During the fiscal year the Soil Conservation Service surveyed all the land under cultivation in the United States—approximately 413 million acres—to ascertain how much of it can be expected to sustain a permanent agriculture under current farm practices. Preliminary results supported the conviction that mistaken land-use and cultural practices in the past have impoverished and ruined by erosion many millions of acres of once produc-

tive cropland. Only 162 million acres were found to be safe from the more serious types of erosion under current farm practices. The tillage practices in use on 251 million acres, or on considerably more than half the land in cultivation, will make profitable crop production impossible if long continued. It is imperative to begin effective measures to check soil wastage.

In seeking through demonstration projects to enlist private and public participation in soil conservation, the Soil Conservation Service selects small areas that generally include about 25,000 acres, and represent as nearly as possible a cross section of a large surrounding region. Then it enters into 5-year cooperative agreements with individual farmers in the areas. The farmers agree to follow recommended land-use and cropping plans, and to furnish part of the necessary labor and materials. In turn, the Service agrees to provide technical assistance, land-use planning, materials and equipment beyond the resources of the individual farmer, and such labor as may be necessary and available.

Actual erosion-control operations in demonstration areas rest on the principle that the use of each acre of agricultural land should conform to the physical and economic environment. Each acre is a separate problem. Its treatment involves the use of detailed conservation surveys, which present a complete picture of the type of soil, the degree of slope, the present land-use practices, and kind and extent of the prevailing erosion.

Vegetative measures, such as strip cropping, contour cultivation, and the seeding and planting of trees, grasses, and shrubs, receive primary emphasis. Permanent erosion control can best be effected through the use of vegetation, and the recognition of this fact has resulted in an expanded nursery program which supplies seedlings, shrubs, and seed for use on demonstration projects. Mechanical structures, such as terraces, check dams, and water-diverting ditches, come next. Such structures may be useful singly or in combination with vegetative control measures.

Advantages of Demonstration Approach

The demonstration method of approach has five advantages, all of which contribute greatly to the success of broader programs: (1) The individual farmer has the problem brought to his attention, and takes an active part in the application of control measures; (2) problems of the individual farmer become problems of the community, and serve to stimulate local interest and participation in cooperative effort; (3) the demonstration area becomes in effect a large-scale display where practical soil-conserving methods and practices can be studied by land users in the surrounding area under actual operating conditions; (4) applied erosion-control measures result in direct benefit to the land; and (5) each project serves as a laboratory where methods can be tested and studied.

FARM LABOR

In seeking to advance the interests of agriculture, this Department has in view the welfare of all the people engaged in the industry, those who till the soil for hire as well as those who cultivate it as tenants or owners. Along with the other agricultural groups, hired farm workers suffered severely during the depression; but when recovery got under way they did not share proportionately in the benefits. Progress toward economic

security and improved living standards among farm laborers depends in large measure, like the prosperity of agriculture in general, on the extent to which the country advances toward a fairer distribution of the national income as between agriculture and urban industry. This alone, however, will not suffice to insure the welfare of the employed group, because their lot depends also on certain special influences that affect farm-labor wages and working conditions.

Agricultural labor has naturally felt the same economic fluctuations that have beset farmers and manufacturers in recent years. It has suffered unemployment and wage recessions, as a combined result of technological advances and of lowered consumer demand for commodities. Farm labor in general does not get enough income to provide an adequate standard of living, and recent economic conditions have confronted it with some new problems. The depth of the depression and its impact on farm wages, the slow development of city outlets for surplus farm labor, the growth of corporate large-scale farming and processing, and the efforts of industrial labor to win more say in the determination of wages, hours, and working conditions have produced a heightened consciousness that farm-labor problems need attention.

Only 20 percent of all the persons gainfully engaged in agriculture are hired workers, whereas in other industries hired labor constitutes the major part of the working force. Farming is still mainly a small family-sized business. Farmers and members of their families do much of the work themselves and require hired labor only as a supplement. In January 1935, when there were 1,646,000 laborers on farms, only 425,000 of them were on farms that employed 5 or more workers. Only 244,000 of them were on farms that hired 10 or more workers.

Farm-Labor Relationship

These conditions differentiate the problem of farm labor radically from that of industrial labor. Most agricultural laborers work singly or in small groups on separate farms in close association with the employers. In 1929 only 8,000 farm units were classed by the census as large-scale farms. This was 0.1 percent of all the farms in the country. Nevertheless, this 0.1 percent paid out 11 percent of the farm wage bill. Among these 8,000 large-scale farms the average wage bill was $13,385, as compared with an average of only $135 on the 6,000,000 family-sized farms. More than 40 percent of the large-scale farms were fruit, truck, and specialty-crop farms, about 25 percent were stock ranches, and 10 percent were dairy farms. In the main the individual farm laborer deals with the individual farm employer. Mass employment of labor in agriculture is uncommon.

Farm production increased after the World War proportionately more than the number of jobs for farm workers. Technological progress in agriculture, particularly in the use of machinery, enabled a given number of farms, with a smaller hired-labor force, to produce from 30 to 40 percent more in 1930 than they produced in 1910. In fact, between these years the number of hired persons in agriculture dropped from 2,895,000 to 2,733,000; and the number of other persons engaged in agriculture, including owners, operators, and family labor, decreased from 9,493,000 to 7,739,000.

After 1930 the number of hired farm laborers dropped still more. It declined by about 20 percent, and the gap was in many cases filled by

tenants and family labor. Agriculture, like industry, can now produce as much as it did in 1929 with a smaller hired-labor force. Ordinarily, increased production per man results in a transfer of farm labor to the cities, without causing any adverse change in the relation of farm wages to farm prices and farm incomes. After 1929, however, farm labor ceased to move freely to the cities. Indeed, urban unemployment generated a movement back to the farms. Therefore, the farm-labor supply became excessive. Farm-wage rates after their decline to the low levels of 1932 have remained low in relation to farm prices, farm incomes, and city-wage levels.

Recent Trend in Farm Wages

From 1925 to 1929 farm-wage rates were at a relatively higher level than farm prices and farm incomes, taking pre-war relationships as a basis of comparison. This was a result of a keen demand in industry for labor, which raised wages in both town and country. In the period mentioned, when farm prices and income were about 50 percent above the pre-war level, city wages were 120 percent and farm wages 70 percent above pre-war. Farm-wage rates lost this industrial support during the depression from 1929 on, and did not regain it during the recovery from 1933 to 1937. Farm wages advanced somewhat after 1932 but not sufficiently to bring them back to their post-war relation to farm prices and city wages. They are now at about the same level as farm prices relatively to the pre-war averages but considerably lower than the average city-wage earnings. It would be necessary to raise them 25 percent higher, in order to restore them to the post-war relation to farm prices, farm income, and city-wage rates.

There is little prospect of that in the near future. Farm wages depend greatly on the income of the farmers, and normal crops during the next few years may reduce farm prices and farm incomes. There is no certainty, moreover, that industrial employment will continue at its present relatively high level. Moreover, technical progress in agriculture will undoubtedly continue and the competition of other countries for a restricted world market will continue likewise. These factors in the outlook for farm wages discourage the hope that improved living standards and greater economic security for farm laborers will come about automatically. Obviously much will depend on the success of the national farm policy in general, since an adequate farm income is the first essential in the maintenance of satisfactory conditions for farm laborers.

Living Standards Among Farm Laborers

Living standards among agricultural workers are notoriously low. Surveys in 10 counties in different States (Louisiana, Pennsylvania, Illinois, Minnesota, Kansas, Iowa, Kentucky, and Colorado) showed that the average annual earnings of farm workers ranged between $125 and $327 for the crop year 1935–36. These incomes may have been helped out by some perquisites, but at that they were not sufficient for health, comfort, and contentment, or saving. Farmers through organization are seeking a fairer share of the national income, and agricultural laborers will want to do the same. This is a natural expression of our developing economic democracy, and should not be met with intolerant opposition. In sections of the country where definite farm-labor problems exist, farm laborers will seek to organize themselves for bargaining purposes and to obtain legislative

help. They will need to work with other farm groups, so that agriculture as a whole may get a fair share of the national income, and they will need to be sufficiently well organized for their own purposes, so that they can get a fair share of that income by methods appropriate to the spirit of agriculture.

Organized movements of agricultural labor, with many strikes, have developed rapidly of late years. The first year of the agricultural depression brought 10 agricultural strikes involving nearly 14,000 workers. In 1933 there were nearly five times as many with 59,000 agricultural workers involved. During the years 1933–36 the number of agricultural strikes reported averaged about 30 and the number of workers involved about 25,000. These figures may be compared with one to four strikes per year in 1927–29, in which period the number of agricultural workers involved in agricultural strikes ranged from 100 to 410. Out of 157 agricultural strikes reported from 1927 to 1936, there were 114 among fruit, vegetable, and truck-crop workers, 10 among cotton workers, and 9 in warehouses and nurseries. The balance, or 20 percent, occurred among sheep shearers, beet, poultry, dairy, and tobacco workers. This occupational distribution of strike activity points to the location of particular sore spots.

The Department's Responsibility

This Department does not consider its efforts at agricultural and industrial recovery successful until it has helped farm labor to participate therein. This is an essential contribution to social justice. It is incidentally a means of promoting the success of future agricultural programs, in which the informed cooperation of hired agricultural workers may be very valuable. Current developments among agricultural workers have significance, not only for themselves and for agriculture as a whole, but for the Nation. These workers move under the impact of social forces like those that drive industrial wage earners. They feel the pressure of technological change, of economic disturbances at home and abroad, of trends in international trade, and of group action among farmers, industrial wage earners, and manufacturers. Where the conditions of its employment approximate those of urban labor, agricultural labor has the same incentive to organize for mutual advancement. For the mass of agricultural labor, however, the attitudes and tactics appropriate in urban organization and bargaining over wages and hours cannot be effectively applied in farm-labor organization and wage bargaining.

Farm-Labor and City-Labor Problems Differ

There are important differences that must always be taken into the reckoning. For the most part, hired agricultural labor deals separately with a large number of individual employers. Each man works more or less in isolation from his fellows and in direct contact with his employer. Agricultural employment is a much more personal relationship than industrial employment. Forces that play on farm workers and employers alike, and that depress the farm-wage level and the manner of working below a tolerable standard, inevitably engender a protest. But the way to make it effective will lie more often through reason, conciliation, and cooperation among the different agricultural groups, than through strife. Intergroup cooperation is necessary, as well as better facilities for action

by each group separately. Agricultural laborers should participate with farmers in the creation, development, and administration of national agricultural programs. This will promote the interests of both groups, and keep them together where otherwise they might part company.

Various divisions of the Department carry on activities with regard to agricultural labor. One division in the Bureau of Agricultural Economics reports quarterly on wage rates, the number of persons employed, and the supply of agricultural labor. Another division of the same Bureau studies farm-population movements and rural life; still another gathers information as to the amount of labor used on farms, and as to farm expenditures for labor. Various branches of the Department study particular aspects of the agricultural labor situation. In the Agricultural Adjustment Administration the Division of Program Planning makes surveys of the principal corn, tobacco, peanut, rice, and sugar areas, to ascertain the effect of the A. A. A. programs on agricultural wages and employment. In 1935, for example, this Division conducted hearings preliminary to the establishment of minimum wages in the sugar-beet areas, in accordance with the provisions of the Jones-Costigan Act. Subsequently, it surveyed agricultural labor in the sugarcane areas of Louisiana.

Through the Resettlement Administration (since superseded by the Farm Security Administration) the Department has established a number of labor camps in California and Arizona, and begun work on others. These camps serve migratory families that cannot find suitable accommodation elsewhere. Communities and cities feel only a limited responsibility for the welfare of agricultural migrants. As a result, these people often lack adequate shelter and sanitation and have practically no facilities for recreation or for the education of their children. The interstate character of migratory labor makes the provision of suitable labor camps a proper Federal function.

Labor Clauses in Marketing Agreements

Marketing agreements sponsored by the Department afford a chance to improve the conditions of agricultural labor. There appears to be legal authority for including in such agreements minimum standards affecting pay and working hours. Such provisions may make the agreements more difficult to administer. They provide a means, however, of eliminating serious evils, such as child labor and excessively long hours, not only in processing and packing plants but in certain agricultural operations. Also they may touch the question of sanitation in working conditions.

It may be possible to include certain requirements in adjustment and agricultural conservation programs, as a condition to the payment of benefits by the Federal Government. Such requirements might advance materially the welfare of agricultural laborers, simultaneously with that of employing farmers. When farmers generally establish certain conditions favorable to their employed workers, the whole industry benefits and no competitive disadvantage falls on any of its members. Another possibility presents itself in connection with the loans that the Farm Security Administration makes through agricultural cooperatives. These loans require certain minimum standards covering employment and the application of the principle might be extended. The whole question of the extent to which the Federal Government may require standards for agricultural labor, as

an incident to other features of its national-agricultural program, deserves further study.

Research Into Labor Problems

Much can be done for agricultural labor through research; it is only as bad conditions are discovered and brought to light that effective remedial steps can be taken. Certain practices, such as the denial of civil liberties to agricultural workers, the oppressive application to them of vagrancy laws, the resort to bailing-out procedures as a means of getting farm labor at low pay, abuses of police authority by local officials, and restrictions of the right of agricultural laborers to organize, demand for their removal chiefly a wider public knowledge that they prevail. Existing legislation for the most part forbids these practices. They continue for want of adequate law enforcement, or because their serious public consequences have not been sufficiently exposed through research and discussion. Research may be invaluable also to provide information regarding the demand for agricultural labor, and to direct migration so that it may be less wasteful. Agricultural labor can benefit from the possession and study of information about the characteristics of various labor markets, and about economic and technological trends affecting agricultural employment. It can benefit also from information that will enable it to participate systematically in the discussion and development of national agricultural programs.

STUDIES IN FARM FAMILY LIVING

Two basic considerations in formulating national and local agricultural policies are the kind of living agriculture makes possible for farm families, and the way the Nation's farms meet their responsibility of providing food and clothing for all families rural and urban. Our knowledge of levels of living of farm, village, and city families has been increased during the year by the Bureau of Home Economics through a study of family consumption according to income. Broadly, the composite picture that has emerged is that of an American farm family generally thrifty, generally well-nourished, producing for itself some of the "protective foods" necessary for dietary adequacy, and generally far less isolated than a generation ago. But there is a darker side to the picture. Many farm families are inadequately fed and clothed. Adequate statistical data concerning the actual and potential production and consumption of the Nation are indispensable in planning and working for improvement.

Appraisal of the living that agriculture provides for farm families must be based on information about farm incomes and expenditures. It is necessary to know the amount of the income from agriculture, and how it is distributed among farm families. Other important questions are: How much of the family's net farm income is money and how much is farm-furnished goods? To what extent is farm income supplemented by money from nonfarm sources? What proportion of the money income is spent for family maintenance? What kind of living is provided by these purchases and by farm-furnished goods?

In appraising agriculture's contribution to the welfare of the nonfarm population, information is necessary about agricultural products, about urban families' expenditures for food, about the kinds and quantities of food

purchased, and about the adequacy of the diets. When diets are inadequate, what is the cause? Unwise food selection, insufficiency of income, or lack of farm productive capacity?

From areas in 21 States selected to represent regionalized types of farming, the Bureau obtained figures showing the total net income of 32 groups of farm families. These figures include both money and nonmoney income from the farm, and also earnings and other money income from nonfarm sources, such as investments. Median family income (net money and nonmoney) ranged from $422 for Negro sharecroppers in one of the southeastern cotton-growing States to $1,540 for white planters in a southeastern tobacco area. Eliminating extremes, the median farm family income ranged between $705 and $1,214 for the middle 16 of the 32 farm groups studied.

The farm families were from a random sample; nevertheless, the net income figures are higher than the national average for the following reasons: (1) They represent only nonrelief families; (2) foreign-born and, in the North, Negro families were excluded to make the sample more homogeneous for the analysis of expenditure patterns; (3) the localities chosen (with two exceptions) were those well adapted to a certain type of farming and therefore usually having farm income above the average.

Farm Families Thrifty

Net money income alone is considerably less than the family's total income, since the net figure excludes income in the form of crops still stored for sale, increases in livestock inventories, and the value of housing, food, and other products furnished by the farm for family living. Average net money income ranged from $182 for Negro sharecroppers in the South to $1,623 for the California orange growers; for the middle 16 of the 32 farm groups, the general level ranged between $394 and $842. This was the amount available for purchases for family living, for payments of debts, and for increasing land holdings, stocks of farm machinery, and other capital goods.

Some of this money income came from nonfarm sources, such as earnings of sons and daughters working off the farm, or interest, rent, and returns from other investments. The importance of such nonfarm income varied greatly. It ranged from 2 percent of the total money income of Negro operators in a tobacco area to as much as 78 percent of the money income of white operators in the marginal farming counties of the southern Appalachians. For the middle 16 of the 32 groups studied, the average nonfarm money income was between 12 and 27 percent of all net money receipts. Mainly, the levels of living possible for farm families depend upon their money income from agriculture and upon the products furnished by their farms.

Thrift seems to be characteristic of farm families. In half of the areas, average living expenditures were below average net money income as soon as families reached the $500 income mark. As income increased, the amount spent for family maintenance rose also, but less rapidly. In the upper income brackets, the family spending only 60 percent of its net cash for living was the rule rather than the exception. This thrift may reflect the American desire for independence as expressed through land ownership. It may be due to the farmer's need for increasing his herds, machinery,

and other capital goods if he is to operate his business successfully. Or it may result from the desire to pay debts contracted during the depression years. Whatever the cause, the tendency to economy in family living is widespread, and represents a real difference from the spending patterns of city families.

Ways of Family Spending

Ways of family spending give some indication of current ideas as to what is most worth while, what goods and services contribute most to satisfactory living. Expenditure patterns of farm families today differ considerably from those of the early twenties. Now, as then, food ranks first in order of magnitude. Despite generous supplies from the farm, average food expenditures of the modal income class of white farm operators now range from 27 percent of total living expenses in the South to 41 percent in Vermont. Clothing expenditures used to rank second in importance; now second rank is claimed by automobile expense among half of the modal income groups. This expenditure represents only the family's share (usually 50 percent) of total expense for car purchase and operation. The increasing importance of the car in the farm family's consumption pattern must mean less isolation, more opportunities for social contacts, more group discussions of agricultural problems by farm men and women, more recreation, and, in general, a better rounded, more satisfying life.

Living levels of farm families are indicated by the value of farm housing and farm-furnished food and fuel, as well as by the purchased goods and services. Average value of farm-furnished goods ranged from $155 to $658 per family. (These money values of food and fuel were based upon what the family would have paid for foods of the same quality and quantity bought from neighbors.) In all but two localities, food of white operators accounted for more than half of the farm's contribution to family maintenance. More than two-thirds of the families had their own eggs and poultry. Outside of California and the Southeast about two-thirds of them had their own milk. Half or more of the farms had potatoes and other garden truck, except in California and the drought-stricken Middle West. Diets ranking high from the standpoint of good nutrition were found almost twice as often among families of white farm operators as among city workers.

However, not all farm families are adequately fed. The diets of about 15 percent of the families of white operators ranked as very poor and of 45 percent as moderately good. About 40 percent had diets nutritionally first-class. The food of Negro operators' families usually was less satisfactory than that of white; the food of sharecroppers was less satisfactory than that of operators. Some of these poor diets resulted from inadequate money incomes and insufficient land, but many could have been improved had the families purchased and produced food more wisely.

Feeding the Cities

What about the job that agriculture is doing to feed the cities? The demands for food over the counters of city and village markets differ greatly from one family to another. Some families carry away less than a dollar's worth per week for each family member. Others spend that much or more in a single day. On tables of the more well-to-do appear

several times as much milk, eggs, green-colored and leafy vegetables, and fruits, as on tables of the poor. These foods add interest and flavor to meals, and help to reinforce diets where they are most likely to be deficient. Among nonrelief families in cities and villages, about one-third spend too little for food to buy anything but second- or third-rate diets. The remaining two-thirds spend enough to buy first-rate diets. Unfortunately, only about one-third of those who spend enough to buy first-rate diets actually succeed in getting them. They fail to choose the proper food combinations. At the most usual food-spending levels (between $2 and $3.50 per person per week for food) diets may be first, second, or third rate, depending on the food choices which the families make.

If all familes could afford diets similar to those ranked as fully adequate by the Bureau, and if all families able to buy good meals made food choices similar to those now made in first-rate diets, the results would be of national import. American stamina and health would be raised to definitely higher levels. American farmers would be called upon to supply larger amounts of certain products and their income would be increased. There would be a demand for at least a 20-percent increase in milk, vegetables, and fruits; about a 15-percent increase in eggs; and considerably increased quantities of meats, breads, fats, and sugars.

The problem of supplying enough food to the large undernourished group of our population is difficult. Farm production capacity is adequate, but the problem involves nonagricultural production, too, and the resulting distribution of the national income. Many families need help in selecting the foods that will give them the best nutritional returns. Only a part of the retail cost of food, in some commodities a very small part, can be charged against farm production. This Department can help by popularizing the results of its research in food composition and in human nutrition, and other agencies both governmental and private can cooperate.

FARM INCOME

Agriculture in 1937 made further progress in recovery from the great depression. Farm-commodity prices were relatively high, as an aftermath of the drought the previous year, and the season's production was more nearly normal. Cash farm income, including Government payments for soil conservation, is likely to amount to nearly $9,000,000,000, or about 87 percent of the average for the predepression period 1924–29. With Government payments left out of the reckoning the income would be about 82 percent of the predepression average.

This income will have a buying power equal to that of the predepression years. Prices of the goods and services that farmers commonly buy were about 14 percent lower in 1937 than they were in the period 1924–29. Hence, $9,000,000,000 cash income in 1937 would have about the same purchasing power as $10,000,000,000 in 1924 to 1929. Agricultural debt charges, taxes, and wage costs were lower also. Allowance for these additional factors raises the agricultural purchasing power of 1937 to a point slightly above the 1924–29 level.

Comparison of the 1937 income with the predepression average, however, makes the present farm situation look better than it is. Farmers were not really prosperous from 1924 to 1929. Farm-commodity prices were then

well above the pre-war level; but nonfarm prices were relatively much higher. This disparity was a constant source of agricultural distress. Moreover, farm-land values were declining, farm-mortgage debt was very burdensome, and farm taxes were high. After meeting the expenses of production, and paying interest and taxes, the farmers had not much left for themselves. It should be borne in mind also, in comparing the 1937 farm income with that of the predepression years, that the farm population is larger now; hence, the farm income must be spread over more people.

Gains of Half Decade

Nevertheless, the recovery in the last 5 years has been remarkable. In 1932, when the depression was at its worst, the cash farm income was only $4,328,000,000. This may be compared with $10,479,000,000 in 1929. Since then the total has climbed steadily by nearly a billion dollars each year. Likewise, the value of the products retained for consumption on the farm has increased. It will be about a billion and one-half dollars in 1937, as compared with less than a billion in 1932. In 1934 and 1936 droughts made the distribution of the farm income very unequal. Farmers in the drought areas earned little, while farmers elsewhere earned far more than usual. This year, with production large in most of the leading crops, the farm income will be spread more evenly throughout the country. More farmers have more income this year than in any year since 1930.

Even in the drought years the regional distribution of farm income was not grossly uneven. Government payments under the A. A. A. programs exercised a stabilizing influence. The 1936 cash farm income, not including A. A. A. payments, was over 80 percent greater than in 1932 in the East North Central and South Atlantic States. The West North Central and the Western States had increases in income of more than 70 percent. In the North Atlantic States, where income did not decline by 1932 as much as in the other regions, the 1936 cash farm income was 47 percent greater than in 1932. The South Central States recorded an increase of 56 percent.

Regional Positions in 1937

For the first 6 months of 1937 each of the principal agricultural regions, except the drought-stricken West North Central area, recorded gains over 1936. The gains ranged from 13 percent in the North Atlantic States to 26 percent in the South Central States. In the West North Central area, the receipts from sales showed a slight decrease for the first 5 months of this year, but the decrease was more than offset by A. A. A. payments. Income from crops in the first half of 1937 increased 26 percent over that for the same period 1936, and livestock and livestock products made a 5 percent gain. A. A. A. payments augmented these increases.

FARM-CREDIT CONDITIONS

Farm recovery appears in a lessened demand for farm-mortgage financing of an emergency character, lessened delinquency in mortgage payments, and a lower volume of outstanding short-term loans. When farmers must borrow, they can do so on better terms; for lending agencies both public and private have reduced their interest charges, and the real and personal property that farmers can pledge as security for loans has risen in value.

The increase in farm incomes, coupled with the decrease in interest charges, has reduced the proportion of the gross farm income that must be set aside for debt service.

Foreclosures and other types of distress transfer of farm property during the depression brought about a heavy liquidation of debt. It was not a desirable kind of liquidation. Farm-mortgage indebtedness dropped one-sixth from January 1, 1930, to January 1, 1935; in total it declined from $9,214,278,000 to $7,645,091,000. This meant, of course, that great numbers of farmers had lost their farms; and those still struggling on had difficulty in obtaining new loans or extensions of old loans. The Federal Government stepped in with two kinds of relief—one designed to restore the farmers' income, and the other to provide new credit facilities. Each form of assistance contributed to the ensuing improvement in credit conditions, but the proportions cannot be determined.

Gains in farm income aided farmers to meet their outstanding obligations, and reduced their need for emergency financing. Even so, there was a heavy demand for refinancing. New loans by the Federal land banks and the Land Bank Commissioner totaled $1,283,503,000 in 1934, the peak year. In 1935 the new-loan total dropped to $445,067,000; and in 1936 to $186,428,000. This was the reflection of a reduced demand. In 1936 the applications to the Federal land banks and the Land Bank Commissioner totaled only 84,030, as compared with 162,968 in 1935 and 502,470 from May 1 to December 31, 1933.

Purposes of New Loans

Farmers are putting new loans to new uses. In 1933, 1934, and 1935, according to a report by the Federal land banks, the main purpose of the loans granted by the Federal land banks and the Land Bank Commissioner was to liquidate long-term and unsecured indebtedness. Loans intended for long-term liquidation in those years absorbed 71.3 percent of the total, and 17.5 went to settle unsecured indebtedness. Only 4 percent financed the purchase of farms. In 1936 the use of loans to liquidate long-term indebtedness declined slightly, the use of loans to refinance short-term debt declined considerably, and the use of loans for land buying jumped to 14 percent of the total. Moreover, the percentage of loans with payments in arrears dropped. In 1933 no less than 53.2 percent of the Federal land-bank loans were delinquent. By January 1, 1937, the percentage had been reduced to 22.5.

These developments have coincided with a great increase in the relative importance of federally sponsored credit agencies in the farm-mortgage field. For example, the Federal land banks on January 1, 1928, held about 12.1 percent of the country's estimated farm-mortgage debt, with 22.9 percent held by life insurance companies. On January 1, 1935, the Federal land banks and the Land Bank Commissioner held 32.7 percent of the mortgage debt, as compared with 16.3 percent held by the life insurance companies. Individuals have become less important as a source of farm-mortgage credit. They held 24.6 percent of the total in 1935, against 29.6 percent in 1928. Banks held a slightly smaller percentage of the total in 1935 than in 1928. Probably the proportion of the farm-mortgage debt held by the Federal land banks and the Land Bank Commissioner is about 40 percent of the total now; for since 1935 farm-mortgage

debt has declined still more, and on the other hand the mortgage holdings of the federally sponsored agencies have increased.

Effect on Land Values

Plentifully available credit for mortgage financing tends to improve land values. Interest rates are the lowest in history, and the proportion of the purchase price that can be financed with a given loan is large. This makes for a livelier farm realty market. Needless to say, however, the rise of farm land values is not an unqualified advantage. It benefits farmers who wish to retire, but new purchasers may discover that even with low interest rates the obligations will absorb a considerable proportion of their earnings. Beyond a certain point, the rise of land values is bad for all concerned; for when depressions come, farms that have been sold do not stay sold, and would-be purchasers find themselves dropping back to the status of tenants. There is so much farm land on the market, however, that the uptrend of valuations tends to be restrained. Meantime, buyers can get very favorable terms. Loans from the Land Bank Commissioner for the purchase of farms can be obtained in amounts up to 75 percent of the normal value of the farms. Private lending agencies have much farm land which they will sell on terms involving moderate cash payments.

In short-term and intermediate-term credit the current supply is much in excess of the demand. Lending agencies supervised by the Farm Credit Administration have a lending capacity much greater than farmers with acceptable credit ratings need or desire to use.

The agricultural loans of commercial banks have steadily declined. Insured commercial banks at the end of 1936 held personal and collateral loans to farmers in the amount totaling only $593,614,000, or 26 percent less than at the end of 1934. Loans of this type at the end of 1936 were less than one-sixth of the amount held by commercial banks at the end of 1920. There has been a slight decline in the aggregate of loans of a similar character held by federally sponsored institutions. These exclude drought, rehabilitation, and seed loans. This whole trend indicates that farmers are becoming less dependent on borrowed funds for carrying on current operations. They are repaying previous indebtedness more rapidly than they are borrowing new money.

Interest Reductions Increase Farm Income

It is interesting to calculate the contribution to net farm income that may come from the reduction in interest rates. Suppose, for example, an individual farm has an indebtedness amounting to exactly four times the average annual gross farm income, and suppose further that this indebtedness bears annual interest payments at 6 percent. In that case the interest payments will absorb 24 percent of the gross farm income. With the annual interest rate reduced to 4 percent, only 16 percent of the gross farm income will be required for the service of the debt.

This lightening of the debt burden tempts many farmers to use an increased proportion of their gross farm income for purposes other than the retirement of debt, and thousands of farms still carry a relatively high indebtedness. There is no formula by which we can determine how much debt a farmer may safely carry. Certainly, however, the indebtedness

should bear a reasonable relationship to the average farm earnings; moreover, it should be adjusted to the well-known liability of farm earnings to fluctuate widely, as a result of price changes and of crop failures.

FARM PRODUCTION

Following the drought of 1936, the year began with a widespread lack of moisture in the Wheat Belt, with food supplies below normal, and with a feed shortage that necessitated reductions in the numbers of hogs and chickens on farms. Notwithstanding the importation of large quantities of feed grain, reserves on farms dropped lower than in any season in many years.

Local continuation of the drought reduced crops and delayed farm recovery in Montana and the Dakotas, in Nebraska, western Kansas, and eastern Colorado, and in parts of Oklahoma and Texas. Though the area affected was much smaller, the loss of crops and the failure of pastures from drought in parts of these States were about as complete as in 1934 or 1936. However, there was less livestock to be liquidated, and the livestock that had to be sold brought good prices.

Outside the persistently dry area (much of which still lacked adequate moisture in October) the season was favorable. In the Cotton Belt a light infestation of boll weevils and favorable growing and harvesting weather gave a large crop. On a moderate harvested acreage (about 34,000,000 acres) the production as estimated in October totaled more than 17,500,000 bales, a record production except for the crop of 1926, when the harvested cotton area was nearly 45,000,000 acres. The 1937 yields will average one-half of a bale per acre as compared with an average yield for the United States of about one-third of a bale per acre. Cotton in 1937 yielded about 12 percent more per acre than in any preceding year.

The production of other crops, though less remarkable, was generally favorable. Excluding cotton, about the usual total acreage of crops was harvested. Composite yields per harvested acre (excluding cotton) were about 4 percent above the 10-year (1923–32) average. There was about an average crop of wheat, large production of nearly all other food crops, and about an average production of tobacco and of feed and fodder. Pastures and ranges were above average nearly everywhere except in the drought areas.

The acre yield of wheat was rather low; this was in part the result of poor moisture conditions left by the 1936 drought. The price of wheat was encouraging, and wheat usually fares better than corn under drought conditions. Wheat growers therefore sowed a record acreage; but continued drought in some areas caused a heavy loss of acreage and reduced the average yield for the country. Production (October estimate) was about 887,000,000 bushels, slightly above the 1928–32 predrought average and much larger than that of any of the past 5 years. Despite a continued lack of moisture in parts of the main Wheat Belt, growers planted another very large acreage in the fall.

There was a large production of rye, rice, beans, peanuts, tree nuts, canning vegetables, and fruits for drying and canning. These large crops will tend to increase the carry-overs into next season and the exports.

Part of the above-average 52,000,000-bushel rye crop will be used for feed. Part of the large 1,270,000-bushel peanut crop will be crushed for oil.

Crops of fresh fruits and vegetables were large and caused serious marketing problems. Portions of the lower grades were not utilized. The potato crop, indicated to be a little under 400,000,000 bushels, was about 7 percent above the 1928–32 average, and represented an ample but not seriously excessive supply per capita. Sweetpotato production, at 75,000,000 bushels, was 13 percent above average, and the price was low. The apple crop was estimated at 207,000,000 bushels, more than one-fourth larger than the average. Part of the apple crop was not picked, because prices were low. The production of apples, peaches, pears, grapes, cherries, plums, prunes, apricots, and cranberries combined exceeded that of 1936 by approximately 45 percent and exceeded the 5-year (1928–32) average by approximately 19 percent. Production of fall and winter oranges and grapefruit will be above average, and the total harvest of walnuts, pecans, almonds, and filberts was more than 40 percent above average.

Feed supplies were ample and new grain moved at low prices. Farmers who fed new grain to milk cows, other cattle, hogs, or poultry generally obtained good returns over the feed costs. The corn crop of about 2,562,000,000 bushels was only about average. The oat, barley, and grain-sorghum crops were approximately average likewise. Hence about the usual tonnage of feed grain was produced. With livestock numbers low, the supplies of grain per unit of livestock on hand are unusually large. Consequently, feed prices are low in comparison with the prices of livestock and livestock products. Opposite conditions existed before the new grain became available. Hay supplies are ample for the livestock on hand.

These conditions will cause feeding per unit of livestock to be rather heavy. Many farmers will increase their production of hogs, fat cattle, and dairy and poultry products. Relatively low feed costs in the fall tended to offset the disadvantage to livestock producers of the high prices of feed and the unfavorable relation of feed costs to the prices of animals and animal products that had prevailed earlier in the year. Hence the carry-over of feed grain into the next crop year may not be burdensome considering the number of livestock there will then be on hand, and considering also the need of farmers who have been pinched by recent droughts to increase their feed reserves. Consumers during the year felt the shortage of meats that resulted from the droughts of 1934 and 1936, but large supplies of other foods gave them partial compensation. Meat prices in 1938 will probably be somewhat below the 1937 average.

COTTON

Cotton incomes have about doubled since the depth of the depression. Income from cotton and cottonseed, including A. A. A. payments, was about 111 percent larger in 1936–37 than in 1932–33. It was about 14 percent larger in 1936–37 than in 1935–36. It is not yet possible to make a close estimate for the current crop season. There is a large crop—17.5 million bales. But cotton prices are now about 5 cents a pound below those of last year. Probably the income from cotton and cottonseed will not be greatly different from what it was the previous year. It may be somewhat lower.

Cotton mills in the United States consumed 7.8 million bales of American cotton in the 12 months ended July 31, 1937, as compared with 6.2 million bales consumed in the preceding year. This high point, which certainly will not be equaled in 1937–38, came about despite a relatively large increase in the consumption of rayon and other textile fibers. In foreign countries on the other hand the consumption of American cotton declined. It amounted in the 12 months ended July 31 last only to 5.3 million bales, the smallest total since the season of 1920–21. Our exports of cotton during the same 12-month period were about the same as the foreign consumption, and 9 percent less than those of the preceding year. Foreign growths have displaced a substantial amount of American cotton in world mills in recent years; and our cotton exports have decreased proportionately.

This development is of great importance to the United States, and successful adjustment to it requires a correct analysis of the causes. Production of foreign cotton now exceeds the production of American. In 1936, when the world's production of all growths amounted to about 30,800,000 bales, only 40 percent of the total was American. In the 10 crop years ended in 1932–33 the American proportion of the world's cotton averaged 56 percent. Since then the consumption of cotton has increased greatly throughout the world, and many countries have striven to profit from the increased demand. This would have cut into the American share in any case; but certain special influences, notably the difficulty foreign countries have in getting dollar exchange, have given foreign cotton an advantage in the world market.

Foreign Cotton Acreage

Cotton acreage has been increasing in foreign countries for many years. As early as 1925 the foreign acreage in cotton reached 43.4 million acres, as compared with 44.4 million acres in the United States. By 1936 the foreign cotton acreage had expanded to 55.7 million acres, while the American total had declined to 30 million. Since 1932 cotton acreage in the United States has been held in check by the amount of from 10 to 15 million acres; in foreign countries it has expanded 13 million acres. This has the look of a cause-and-effect relationship. As a matter of fact, the acreage-adjustment program in the United States was only one of a number of factors responsible for the expansion of cotton production in foreign countries.

This can be demonstrated without difficulty. American cotton has been abundant and cheap since 1932. During the 1935–36 and 1936–37 seasons the price of American cotton was not out of line with the prices of other cottons. In 1933 the crop plus the world carry-over amounted to almost double the world's consumption of the American growth. Stocks have been reduced each year since then; but they have never ceased to be ample. The Government had more than 5 million bales of loan cotton on hand at the beginning of the 1935–36 season. Probably the 12-cent loan of 1934 hampered the export movement of American cotton, and tended to favor foreign growths in world consumption; but considering the ample supplies we had on hand, it seems doubtful that the acreage adjustments of 1934 and 1935 had much influence. Stocks of all American cotton in the world on August 1, 1937, totaled 6,200,000 bales, as compared with 7 million bales a year earlier. The total supply of American cotton for the current market-

ing season will be about 23.7 million bales, or considerably more than the probable consumption, plus a normal carry-over. In short, the United States in every year since the depression has had more cotton on hand than the total market, domestic and foreign, would absorb at the prices maintained.

Controlling Influences in World Cotton Trade

Among the forces that have stimulated the consumption of foreign at the expense of American cotton in the last decade or so must be included the disposition of cotton-consuming countries to buy cotton where they could sell manufactured goods in exchange. This country's high tariff made it practically impossible for them to do so here. Accordingly, as supplies became available they turned to Brazil, Africa, and India for larger quantities. Moreover, cotton growers at home and abroad vary their cotton acreage, not only in response to past cotton prices and cotton incomes, but in response to credit conditions, production costs, and the prices of alternative crops. In recent years cotton has been more profitable than coffee in Brazil and than grains in India, Egypt, and Argentina. In some countries cotton acreage has expanded for reasons quite unrelated to the price or supply of American cotton.

Consider, for example, four cotton-growing countries—the Union of Soviet Socialist Republics, China, Brazil, and Uganda. The Union of Soviet Socialist Republics' economic program brought an expansion in that country from less than 200,000 acres of cotton in 1922 to 2.6 million acres in 1929 and to more than 5 million acres in 1936. In that expansion it is impossible to detect the influence of variations in the supply and price of American cotton. The Union of Soviet Socialist Republics expanded its cotton acreage regardless of fluctuations in cotton prices on the world market.

China likewise increased its cotton production for reasons largely unrelated to American conditions. It expanded its acreage from 5.5 million in 1922 to 6 million acres in 1929, and to 8.5 million in 1936. As showing China's indifference to American supplies and prices, we may note that China went down somewhat in cotton acreage following high prices of American cotton from 1922 to 1925 and went up following low prices of American cotton in 1932. China forges ahead in cotton growing, without paying much attention to what other countries do, because it has an increasing demand at home, and special facilities for supplying Japan.

Position of Brazil

In Brazil, where the acreage in cotton increased from 1.7 million in 1929 to 6.4 million in 1936, the principal stimulating influence was the low price of coffee. Cotton was a welcome alternative to coffee growing there, even when cotton prices were extremely low, because the coffee situation had grown more and more difficult to handle. This factor and certain associated influences appear, according to an analysis made by the Bureau of Agricultural Economics, to have played a part in Brazil's cotton expansion several times as great as the part played by the price of American cotton.

Still another country in which cotton acreage has increased rapidly is Uganda, where the acreage in 1936 was 1,488,000, as compared with

165,000 acres in 1921. Uganda increased its cotton acreage by more than 400,000 acres from 1929 to 1932, when cotton was a drug on the world market. Half the increase in the foreign cotton acreage since 1932 has taken place in countries where American cotton acreage and prices are not a governing factor. In the countries responsible for the rest of the increase, factors besides the price of American cotton have also been influential.

It is one thing, however, to analyze the causes of the shift from American to foreign growths in the world's consumption of cotton and another to develop an appropriate American cotton policy in relation to that change. It seems improbable that this country will regain its former proportionate share in the world's cotton trade; but it may win back a greater total export trade in cotton than it has ever had before. Cotton consumption is increasing, despite the competition of rayon and other synthetic textile fibers. Better conditions in international trade might increase the consumption immensely, perhaps in directions as yet scarcely entered upon. There is a huge potential demand for cotton clothing, which will become actual as purchasing power rises. Certain of the newer cotton-growing countries will probably themselves supply the increase in their dometic demand; but even in Europe economic recovery will mean more consumption of cotton, and presumably some increase in the demand for American growths. It does not follow, because world competition in cotton is increasing, that the United States must resign itself to a constantly diminishing cotton trade.

Action Along Two Lines Needed

Necessarily, however, the retention of our place in the world's cotton market will require vigorous action along two lines: First, and most important, toward improved international trade relationships, and a more liberal attitude by the United States itself toward imports; and second, toward a rational crop adjustment, which will correctly balance price against volume so as to give the largest net farm income. In the long run the world price of cotton will be determined by the total world supply and demand relationship. Cotton acreage adjustment in the United States should be a flexible, changing adaptation to the changing domestic and world market situation, with allowance for the necessity of selling abroad each year something like 40 percent of our cotton crop.

With its exceptional facilities for growing cotton this country need not fear competition in the world's cotton market. It may require a production of around 13 to 14 million bales annually on the average to furnish an adequate, continuous supply. How much acreage this goal will require depends of course on the yields, which have increased in recent years largely as a result of the soil-conservation programs. It may be possible to satisfy the domestic and foreign demand on a cotton area considerably smaller than the 34,192,000 acres planted to cotton in 1937. But the fundamental difficulty is not with production. It is not the supply, but the foreign consumption of American cotton, that tends to lag. Largely the cause is international trade restriction, in the growth of which the United States has contributed its share. Therefore, the remedy must be sought principally in efforts to restore reciprocal international trade.

Not Exclusively a Price Problem

It should be reiterated that the problem of restoring America's share in the world's cotton trade is not exclusively a price problem. Doubtless our price policy in 1934, when Government loans caused cotton to accumulate in storage here, contributed something to the long-time tendency for American cotton to become a smaller proportion of the world's total cotton consumption. In 1935 and 1936, however, this price policy did not prevail. In those years the price of American cotton bore the normal relation to the prices of foreign cottons. For example, American cotton was about 20 percent dearer than Indian, just as it was prior to the depression. This differential mainly reflected quality differences. Yet in 1935 the American share in the foreign cotton consumption was only 32 percent, as compared with 45 percent prior to 1929. In 1936, with the normal cotton-price relationship again prevailing, the American share in the foreign consumption of cotton was only 23 percent. It is clear that the problem of restoring our share of the world's cotton consumption involves more than simply the maintenance of competitive prices.

Nevertheless, if we wish to keep and to increase our share of the world's cotton market, one of the requirements is that we shall produce enough cotton and offer it at a competitive price. There is no possibility of getting a parity price for export cotton. Some type of benefit payments will continue to be necessary, if the cotton South is to have its fair share of the national income. The more income we get for our export cotton, the less expensive it will be to compensate the cotton growers for the inevitable handicaps imposed on them by the existing tariff system.

Foreign production of cotton for the current season will probably again increase, but probably not to the same extent as the American crop. Consequently the United States proportion of the world's supply, for the third successive year, will be more than it was in the previous season. It is necessary to bear in mind, however, that our 1934 crop was very small. World business conditions improved in 1937 despite war scares and certain elements of unsoundness in the economic situation. Continued similar improvement in the first half of 1938 is scarcely likely. In the later months symptoms of reaction set in; textile activity declined and also cotton prices.

The Cotton Loan

This situation led to a demand for certain loans. The Administration provided a new cotton loan and Congress appropriated $130,000,000 from what is known as section 32—money to finance cotton price-adjustment payments of not to exceed 3 cents a pound. These payments, according to the act, are to be contingent upon the enactment of new farm legislation and the cooperation of farmers in a program under this legislation in 1938. Because the funds are limited the price-adjustment payments will be made on 65 percent of each producer's 1937 base. The loan figure has been set at 9 cents a pound on cotton of ⅞-inch staple and Middling grade. The 9-cent loan value, the 3-cent payments, and the conservation payments under the A. A. A. program make a total of about 14 cents per pound on a quantity in excess of a year's domestic consumption.

Loans have their place in cotton policy; but used for any length of time to keep the domestic price of cotton above the world price, they have two bad

results: (1) The Government acquires a huge supply of cotton in loan stocks that constitute a weight on prices of American cotton, and (2) American cotton does not move freely into the export trade because foreign cotton, unaffected by such loans, can be had at a lower price. The 10-cent cotton loan of 1933 helped to give farmers rather than speculators the advantage of the subsequent rise of prices, and this year's 9-cent loan should check the price decline. Nevertheless, such loans are stimulants. They may do harm if overused or used in the wrong way. High loans necessitate rigid control of production; otherwise the Government lets itself in for a heavy loss. Then, as the American proportion of the world's production declines, it takes more curtailment of our acreage to produce a given increase in the world price.

There are limits beyond which the adjustment of cotton production cannot be pressed. These limits also influence the amount that can prudently be advanced in cotton loans. Conversely, with the capacity of our cotton-growing industry far above the profitable demand, there are limits to the profitable acreage. Continued unrestricted production would mean very low prices. Too little and too much production may be equally disastrous. The welfare of the South requires a middle course, which will keep the place of the United States in the world's cotton market without swamping that market periodically. The South needs increased production of home food and feed crops, stimulation of cotton consumption within the United States, continued moderate adjustment of production, continued soil conservation and soil building, and conservation payments including price-adjustment payments to the cooperating producers.

It is certain that the carry-over of American cotton on August 1, 1938, will show a substantial increase over that of the previous year. Rayon and other synthetic textile fibers continue to be formidable substitutes for cotton. In 1936 the world's production of rayon yarn and rayon staple fiber (in units of weight equal to the weight of an average bale of cotton) amounted to the equivalent of about 2,730,000 bales (478 pounds net), against about 2,240,000 bales in 1935 and an annual average of only 677,000 bales during the 10 years ended with 1932. Japan surpassed the United States in rayon production for the first time in 1936. The United States this year will have nearly 10 million bales of cotton to put on a world cotton market which seems to need only 3 or 4 million bales. A world cotton problem of great magnitude is upon us.

WHEAT

After 4 years of small wheat crops, wheat production in 1937 is again large enough to provide a surplus for export. This return to an export basis brought about a sharp reduction in the farm price of wheat in the United States during July and August. As a result of short crops in other countries, however, world wheat prices were higher in 1937 than in 1936. Therefore, our prices came into an adjustment with world prices on a higher level than would have resulted had wheat production been normal throughout the world.

Throughout the 1937–38 marketing season, the United States probably will be the world's largest exporter of wheat. This is in sharp contrast with the situation last year, when our wheat crop was barely equal to the normal consumption in the United States. The prospective world wheat supply

for the crop year, outside of the Union of Soviet Socialist Republics and China, is about the same as the supply for 1936–37. Present indications are that with the exception of 1936–37 the world wheat supply will be the smallest since 1926.

Our production is about 887 million bushels. If this quantity had been distributed among the different commercial classes of wheat in about normal proportions, there might have been an exportable surplus of 200 million bushels from the 1937 crop in the United States. Because of the drought in the Great Plains region, however, there is no surplus of Hard Red Spring and durum wheats. On the other hand, there are surpluses of Soft Red Winter and White wheats in excess of probable domestic requirements and exports. There will also be a surplus of Hard Red Winter wheat, but there is a satisfactory demand for this class of wheat on world markets. Hence, although there may be a carry-over on July 1, 1938, of approximately 200 million bushels, this carry-over will be made up of normal minimum amounts of Hard Red Spring, Hard Red Winter, and durum wheats, and of surpluses of Soft Red Winter and White wheats.

Wheat Acreage Expanded

Our small crops during the past 4 years resulted from heavy abandonment and unusually small yields per acre. Farmers maintained their seeded acreage at a high level. Sown acres for harvest in 1937 were the largest in the history of the country. Small crops reduced the record surplus that existed in 1933, and by July 1937 carry-over stocks had been reduced below normal. But the existence of large carry-over stocks at the beginning of the low-production period reduced the need for wheat imports into the United States. Such imports as have occurred during the past 3 years have consisted of high-grade Hard Red Spring and durum wheats. Millers in this country have preferred to pay the duty on a limited quantity of high-quality wheats, in preference to using larger amounts of soft wheats that were available in this country. Hence imports during the past 3 years have represented, not a deficit in the total supplies of wheat in the United States but rather a deficit of wheats of certain qualities. This deficit was the result of adverse weather conditions in the Great Plains region.

Because of the shortage and high price of feed grains in many parts of the country, as compared with the supplies and price of wheat, an average of about 85 million bushels of wheat annually was fed to livestock on farms during the past 4 years, as compared with an average of about 45 million bushels in the period 1925–26 to 1929–30. This increase in the use of wheat as feed served to increase the total wheat disappearance in the United States. It rose from an average of 630 million bushels for the 1925–26 to 1929–30 period to 660 million bushels, the average for 1933–34 to 1936–37. Wheat ground for food and commercial feeds declined slightly between these two periods.

The Pacific Northwest, the principal white wheat region, continued to produce a regional surplus. In 1933–34 processing taxes financed the disposal of this surplus. In 1935–36 and 1936–37 the Government indemnified exporters in the Pacific Northwest for losses on exports to the Philippine Islands. Funds for the indemnity came from tariff revenues under section 32 of the amended Agricultural Adjustment Act. Considerable amounts

of White wheat from the Pacific Northwest moved east of the Rockies, both by water to Gulf and Atlantic points and by rail to the interior, and some of it went into relief channels. This year, with wheat generally on an export basis, wheat from the Pacific Northwest will not compete directly with eastern-grown wheat, except in limited quantities in the form of flour.

Programs for Different Types of Wheat

In making plans for the future, it will be necessary to take into consideration the different classes of wheat and the climatic and economic conditions in the various wheat-producing regions. Generally, the different kinds of wheat may be substituted for one another in the milling process. There is a limit, however, beyond which millers will not go in making substitutions. For instance, the manufacture of high-quality macaroni and spaghetti requires Amber durum wheat. When there is a deficit of Amber durum wheat of the proper texture in the United States, the trade will pay the import duty on a sufficient quantity of Canadian wheat to make up the deficit, in preference to utilizing wheats of other quality which may be available within this country.

During the past 10 years the United States has not exported Soft Red Winter wheat in any appreciable quantity. This has been due (1) to the fact that European nations produce a sufficient quantity of this kind of wheat to meet their requirements, and (2) because Soft Red Winter wheat is produced in the United States in regions where other crops have proved more profitable than wheat at the price relationships that have existed. An exception occurred in 1936 and 1937 when the prospects for higher-priced wheat and the killing out of pasture and hay lands brought forth a greatly expanded wheat acreage.

In the Pacific Northwest the comparative advantage of wheat growing is so great that prices relatively lower there than in the rest of the country have not caused a shift to other crops. Growers in this region have continued to produce a surplus of wheat, despite declining export markets, and despite the impossibility of disposing domestically of all of the White wheat grown within the United States.

There is no likelihood of a shortage of Soft Red Winter and White wheats in the United States. Only such shortages of Hard Red Spring, Hard Red Winter, and durum wheats are likely to occur as may be caused by unusually adverse seasons. Any reserves that may be stored in an ever-normal granary should consist of Hard Red Spring, Hard Red Winter, and durum wheats. There is no need of storing White and Soft Red Winter wheats in order to assure a uniform supply.

Action of Noncooperators

During the first 3 years of the A. A. A. adjustments, noncooperators expanded their wheat acreage, and tended to nullify the adjustments made by cooperating producers. This would happen in any period of rising prices. Noncooperators might not expand their acreage during a period of falling prices as much as they did during the years 1933–35. The original wheat-adjustment program sought to maintain parity returns on the portion of the crop required for domestic needs. Payments to growers were to become greater as prices declined, and smaller as prices advanced. This procedure would have tended to reduce the surplus, even had normal

weather continued. But the droughts of the period 1933–36 caused the surplus to disappear with unexpected rapidity. Accordingly, wheat prices in the United States rose above world wheat prices, and our wheat acreage continued to increase.

Normally, unless the United States reduces its wheat acreage below any probable level, there will be an exportable surplus in this country. It will consist chiefly of Hard Red Winter and White wheats. Any adjustment program that may be undertaken by the Department of Agriculture can affect prices only to the extent of the differentials between United States prices and prices abroad. It cannot have any material effect upon world prices, because the United States produces less than one-fourth of the world wheat crop. Any loan program applied to wheat must take this fact into consideration. The amount of the loan must be determined in the light of world conditions, as well as in the light of conditions within the United States.

Moderate Production for Export Desirable

Wheat producers in the United States cannot expect to receive parity prices over a period of years, unless they reduce their acreage to domestic requirements or unless the Federal Government subsidizes wheat growing more than it has done heretofore. Domestic requirements can be met on about 55,000,000 seeded acres. That is 25,000,000 acres less than the area seeded for the 1937 crop; it is 12,000,000 acres less than the average for the 1928–32 period. Adjustments drastic enough to place the United States wheat crop on a domestic basis do not seem practicable, and any attempt to make them would probably dislocate the farming system in wheat areas.

The wiser national policy would seem to be a middle course. It would aim to produce enough for domestic requirements and about 50,000,000 bushels for export. That would require on the average about 60,000,000 seeded acres. With seedings held to that level, the ever-normal granary could stabilize the supplies and avoid burdensome carry-overs. Any area in excess of 60,000,000 seeded acres over a period of years would probably cause the accumulation of surpluses and a recurrence of the conditions that faced the wheat farmer in 1932.

MEAT ANIMALS AND FEED

Cash farm income from meat animals in 1936 totaled approximately $2,000,000,000. This was the largest for any year since 1930, and was more than twice as large as the very low income of 1932. Percentage increases in farm income from the several species of meat animals from 1932 to 1936 were: 117 percent for hogs, 87 percent for cattle and calves, and 97 percent for sheep and lambs.

There was a further increase in the income from farm marketing of meat animals in the first half of 1937, in which period the total was about 3 percent greater than in the first half of 1936. The improvement resulted from a strengthened demand and a reduction in slaughter supplies of hogs and of the better grades of cattle. In areas affected severely by the droughts of 1934 and 1936 the income of livestock producers increased less than in the country as a whole and the expenditure for feed in those areas was large.

Moreover, much of the recorded increase in the income from livestock

in the drought-stricken areas resulted from the liquidation of flocks and herds. Producers sold part of their capital assets. Marked curtailment in the production of feed, and poor pasture and range conditions in 1934 and 1936, left them no alternative. In only 2 years since 1929 has corn production been equal to or above the long-time average.

The deficiency of feed grains in the Corn Belt in the last 3 years resulted in relatively high corn prices there. Approximately normal corn production in all areas this year will involve a sharp adjustment of corn prices between areas. The greatest decline in prices is to be expected in the surplus-producing areas of the Corn Belt.

Feed-Grain Supply Position

In Missouri, Kansas, and Nebraska the production of corn in each of the last 3 years has been less than one-half the average. The disappearance of feed grains was rapid last winter. This year's crop will help to replenish the supply. With the number of grain-consuming animals on farms about 10 percent below the 1928–32 average, and especially low in the Middle West, the crop will mean a larger-than-average supply of feed per animal. In some Corn Belt States it will be much above last year.

On January 1, 1937, the number of all cattle on farms west of the Mississippi River was about 7 million head, or 15 percent smaller than on January 1, 1934. More than half of the reduction was in the western Corn Belt. East of the Mississippi River the number of cattle on farms at the beginning of 1937 was about as large as at the beginning of 1934. Cattle located west of the river represented a smaller proportion of the country's total than at any time in the preceding 20 years.

The reduction in hog numbers has been much greater in the western Corn Belt than elsewhere. From January 1, 1933, to January 1, 1937, the number of hogs on farms decreased from 62,127,000 to 42,774,000 head, a reduction of 31 percent. More than two-thirds of this decrease occurred in the western Corn Belt. From 1933 to 1937 the proportion which the number of hogs in this region represented of the United States total declined from 46 to 34 percent. In the post-war period prior to 1930 the western Corn Belt, or the West North Central States, usually produced more than half of the total national supply of hogs, and nearly 40 percent of the total output of beef.

Livestock production will probably not return to normal in the western Corn Belt in 1938. Several years of good crops and favorable pasture conditions will be required.

DAIRY PRODUCTS

Gross farm income from dairy products, which dropped to $1,260,000,000 in 1932, was approximately $1,850,000,000 in 1936. The increase was due mostly to the improved demand situation and the rise in the prices of dairy products.

The droughts of 1934 and 1936 handicapped dairying throughout the country, because the resulting short crops raised feed prices relative to milk and butterfat prices. This year's more normal feed crops will make the dairy products-feed price ratio more favorable for dairy producers.

The droughts did not reduce milk production as much as might have been expected. In the 1934–35 season total production was only about 5 percent less than it probably would have been with average sized crops. The effect of the 1936 drought on milk production was no more serious. Conversely, it is likely that more normal feed-crop production will result in only a moderate increase in milk production.

The number of milk cows is now 7 percent less than the large number on January 1, 1934, and is about in line with the long-time upward trend since 1900. Most of the decrease in milk cows has been in the drought areas, though the favorable market for beef and the disease-elimination programs have contributed to the general decrease. With more normal crop-growing conditions, farmers may be expected to build up their drought-depleted herds and to replace the eliminated diseased cows.

The general shift from soil-depleting to soil-conserving crops, involving an increase and improvement in pastures and legume crops, is favorable to a resumption of the upward trend in milk cows. However, it is unlikely that the number will show a marked increase during the next year or two. Prices of beef cattle and hogs are high relative to prices of dairy products and the outlook is for greater expansion in meat production than in dairy production.

Rise of Dairy Prices

Farm prices of dairy products rose from a low of 71 percent of the prewar level (August 1909–July 1914) in March 1933 to 120 percent of that level in 1936. Adjusted for seasonal variation, they averaged nearly 122 percent in the first 8 months of 1937. This represented the highest level since 1930, though still considerably below the 1925–29 average of 155 percent.

Butterfat prices in July and August were not so high as in those months last year, when they rose sharply because of the drought, but producers generally were in a better position. Feed prices were declining and pastures were in good condition. While milk production was fairly heavy, consumer demand was relatively strong.

As in 1934–35, a substantial quantity of butter was imported in 1936–37. Rising domestic prices in the summer of 1936 began to attract moderate imports. Butter imports for the 1937 fiscal year totaled 14,786,000 pounds, a volume equivalent to 1 percent of domestic butter production. Since April the spread between domestic and foreign prices of butter has been too narrow to attract significant imports. In 1936–37 cheese imports totaled 65,694,000 pounds, the largest volume since 1929–30, and equivalent to 10 percent of total domestic cheese production.

There has been a pronounced recovery in the demand for fluid milk, cream, and ice cream. Milk and cream consumption per capita (milk equivalent) in cities and villages dropped about 12 percent from 1929 to 1934, but now the trend is again upward. This represents an improvement in conditions in the fluid-milk areas and tends to lessen the effect of the increase in total milk production on the volume of production of manufactured dairy products. Per-capita production of ice cream (factory), which declined 45 percent from 1929 to 1933, has increased rapidly, and it seems probable that production in 1937 will exceed the preceding peak in 1929.

Effect of Dairy Programs

The present dairy programs are helping to improve the dairy situation. Marketing agreements and orders are resulting in more orderly and stabilized conditions in many fluid-milk markets and in the evaporated-milk and dry-skim-milk industries. The dairy-products-purchase program is removing temporary surpluses from the commercial trade channels. Under the disease-elimination program, farmers are receiving financial assistance in cleaning their herds of diseased cows.

In general, the immediate outlook for dairying probably is the most favorable since 1930. Future dairy-adjustment problems will relate to maintaining the upward trends in dairy incomes and prices in step with general economic recovery and in balance with other farm incomes and prices. It is unlikely that there will be need for a general dairy-adjustment program to reduce dairy production in the near future.

FRUITS AND VEGETABLES

Prices and income received by fruit and vegetable producers have increased sharply from the depression low point, though the production has increased. More citrus fruits, pears, and cherries have offset decreases in the production of apples, peaches, and grapes. The general level of production of potatoes and sweetpotatoes has remained fairly constant. Production of truck crops for the market and for canning has risen in line with the trend of the last 15 years.

Generally, the demand for fruits and vegetables is such that the year-to-year variations in the output appear to have very little influence on the income of the producers. Small crops of fruits usually return about the same gross income as do large crops under the same demand conditions. This applies also to truck crops for market. With potatoes, however, the gross income to producers decreases as the size of the crop increases beyond a certain point; while with sweetpotatoes and truck crops for canning the reverse is true; increases in production cause increases in the income, provided there is a market outlet. Broadly speaking, incomes to producers of these commodities as a group vary closely with the incomes of urban consumers.

Prevailing prices for many fruits and vegetables encourage a more normal distribution of these commodities, and establish a wider general market. In the depression period the prices of some of these commodities declined to such low levels that producers refused to harvest portions of the production.

The Potato Problem

Potato prices are extremely low this year. At country markets in August the prices ranged from 30 to 50 cents a bushel. Such prices do not cover costs, and growers asked the Agricultural Adjustment Administration to coordinate their efforts toward getting better returns. This can be done with benefit to consumers also.

Not all the potatoes seen in grocery stores are of good quality. Frequently the offerings include small or damaged potatoes. This is unnecessary when we have a big supply of good potatoes. Culls and other low-

grade potatoes hurt the market and prevent consumers from getting their money's worth.

Low prices do not necessarily protect the people who buy potatoes; they may herald a shortage and high prices the next year. Consumers are better off when prices are stable at a fair level. They pay more in the long run when growers cannot market their potatoes efficiently and when handlers lose money in unstable markets. In years of moderate production and marketing, consumers pay about 20 cents a bushel less than they do on the average when the market goes very high. Potato growers have had relatively low prices in 3 out of the last 5 years—1934, 1935, and 1937. They got relatively low prices similarly in 1931 and 1932. About a quarter of a million people make their living by growing potatoes, and about half a million people depend on potatoes for a good share of their living. Low returns from potatoes hurt much other business.

Marketing Agreements Approved

Marketing agreements may help to solve the problem. With this in mind, the A. A. A. discussed the situation with growers at public hearings in various potato-growing States. Following these hearings it submitted similar proposed marketing agreements to the growers in four commercial areas, namely: (1) Idaho; (2) Colorado, Nebraska, and Wyoming; (3) Michigan, Wisconsin, Minnesota, and North Dakota; and (4) Maine. In the first three of these areas the potato growers favored the proposed agreements by more than two-thirds majorities. In Maine, on the other hand, the growers voted against the proposal. Accordingly, the A. A. A. put orders in effect in October in the three areas that had voted for them.

Under the agreements, potato shippers will not make any out-of-State shipments of culls or other low-grade potatoes. Culls are potatoes that measure less than 1½ inches in diameter, and other low-grade potatoes include bruised and partly decayed ones. With such potatoes kept off the market, the consumer would have a better chance of buying good potatoes without also paying for poor ones. At present he pays for waste on the market and for inferior products. Waste always accompanies a glutted market.

The marketing agreements apply only to shipments out of one State into another; they represent Federal cooperation with the growers, and keep culls and other low-grade potatoes out of interstate commerce. Some States have regulations on the sale of potatoes within their borders.

The Agricultural Adjustment Administration has been buying surplus potatoes, and giving them to people on relief since last May in an effort to prevent market congestion. But it is impossible, and probably not in the public interest, to buy a large part of the surplus. With the assistance of marketing agreements, the A. A. A. will be able to do a more effective job at less cost. In combination, the purchase program and the agreements should promote orderly marketing, check waste, relieve the downward trend of potato prices, and protect the general public.

Future Acreage Stabilization

During September, when the growers of designated areas were considering marketing agreements, commercial potato growers in all parts of the country took a step toward acreage stabilization in the future.

By a vote of nearly 5 to 1 they approved a plan to establish potato-acreage goals next year, under the provisions of the 1938 agricultural conservation program. The object of the potato goals would be to hold commercial acreage at a point near the average for the past 10 years, and avoid both excessively high and excessively low acreage. The potato program will apply only to commercial farmers who are cooperating in the voluntary agricultural conservation program. It will not apply to farmers who grow potatoes primarily for home use.

Acreage stabilization, together with the marketing programs, should constitute a balanced supply that will benefit both growers and consumers.

SUGAR

For producers and consumers of sugar the enactment of the Sugar Act of 1937, which became a law on September 1, was one of the significant agricultural developments of the year. The new law provides for the continuation until December 31, 1940, of the sugar-quota system originally established under the Jones-Costigan Act in 1934 and authorizes conditional payments to growers of sugar beets and sugarcane who comply with specified standards relating to labor conditions, soil conservation practices, and marketing allotments. In the case of producers who are also processors, payment of fair prices to other growers is a requirement of the program.

The Sugar Act of 1937 was passed to remedy the situation in the sugar industry created by the decision of the United States Supreme Court in the *Hoosac Mills case* on January 6, 1936, which invalidated the processing tax and production-adjustment provisions of the Jones-Costigan Act while leaving in effect the quota system which assured a protected market for sellers of sugar. The Jones-Costigan Act, amending the Agricultural Adjustment Act, made available to producers of sugar beets and sugarcane the benefits afforded to producers of other major agricultural commodities. The program established under this act met the approval of practically all groups in the sugar industry. The returns to domestic sugar-beet and sugarcane producers were increased considerably, the hiring of young children for work in the fields was reduced, and the income of adult laborers was increased substantially. The income of sugar-beet and sugarcane processors was also increased markedly. At the same time there was only a small increase in the cost of sugar to consumers. The national average retail price during 1933 was 5.4 cents a pound, 5.6 cents in 1934, and 5.7 cents in 1935. The program was on a self-financing basis; the processing tax of one-half cent a pound, yielding approximately $64,000,000 annually, was sufficient to meet benefit payments and other costs of the program.

The invalidation of the processing tax and production-adjustment provisions of the program resulted in an inequitable redistribution of income under the quota system. The retail price showed only a small decrease in 1936; the price averaged 5.6 cents per pound; but there was a loss to growers, laborers, and taxpayers, and a corresponding gain to domestic sugar processors and foreign sugar producers. Through Public Resolution No. 109, approved June 19, 1936, Congress extended the quota provisions of the Jones-Costigan Act through December 31, 1937.

The Sugar Act of 1937

Sugar-beet and sugarcane producers were eligible to participate in the agricultural conservation program developed under the Soil Conservation and Domestic Allotment Act of 1936 and special provisions were established in this program for maintaining the national acreages of these crops along with soil conservation measures. Desirable as these features were, they proved an inadequate answer to the economic and social problems facing the sugar industry, and there was increasing demand for new legislation. The necessity for governmental action was recognized by the Presidential message to Congress of March 1. The Sugar Act of 1937 was the result.

Under this measure total supplies of sugar required by consumers are determined for each year and apportioned among the various producing areas that supply the United States market. Consumers are protected by provisions that give the Secretary of Agriculture authority to make allowances for changes in consumption and to prevent any possible restriction of supplies of sugar under the quota system which would result in prices to consumers in excess of those reasonably necessary to maintain the domestic industry as a whole. The policy of including among the conditions for receiving a Federal payment the prevention of child labor and the payment of wages of not less than minimum standards, which was initiated in the Jones-Costigan Act, has been more effectively provided for in the new act.

As a result of the balancing of available supplies and consumers' needs through the quota provisions of the act, through conditional payments to growers, and through the excise tax of one-half cent per pound, both growers and laborers should get a fairer share of the total income of the domestic industry. Moreover, the net revenue to the Federal Government from sugar should increase over the level of recent years, without raising the cost of sugar to consumers.

TOBACCO

With prices generally above those for the 1935 crop the tobacco situation in the 1936–37 marketing year was favorable to the growers. Production will be larger this year but the increases do not appear to be greatly out of line with market requirements. Income to growers from the sale of leaf tobacco has increased each year for the past 5 years.

Supplies of tobacco in the United States have been large in the last 6 years in comparison with supplies in earlier years; yet improving demand conditions and expanding consumption of tobacco products during the past 3 years have resulted in an improved situation for the growers of tobacco. Domestic production reached a record high level in 1930, while stocks in the hands of dealers and manufacturers did not reach their peak until 1932.

Growers have held down their production since 1932. Stocks in general have remained large, although notable decreases have occurred in some types. However, in view of the increasing domestic consumption of tobacco products, the annual carry-over no longer appears excessive.

Tobacco consumption has increased most markedly in cigarettes. Naturally the cigarette types, chiefly flue-cured and Burley, have benefited. Increasing demand, together with a small supply, resulted in an average price for Burley in 1936 of 36 cents per pound, the highest on record.

Cigar consumption has increased since 1932; snuff consumption has increased slightly, and the consumption of chewing and smoking tobacco has remained practically unchanged. Exports of tobacco have not returned to their predepression level; but increased domestic consumption seems to have compensated for the loss, except in fire-cured tobacco.

CROP SHIFTS SINCE THE WAR

Agriculture like other living things has the faculty of adapting itself to changing conditions; but rapid change in these conditions strains its powers of adaptation. In the last 20 years or so the conditions that affect agriculture in the United States have changed tremendously. Scientific and technical progress have revolutionized methods of farming; and economic developments at home and abroad, particularly those produced by the World War, have reshaped the agricultural market. There has been a lack of harmony between the technical and the economic developments. Technical progress has increased the farmer's productivity, while economic happenings have restricted the demand for his products.

This conflict has forced agriculture into extensive readjustments both in production and in marketing, but the resulting new equilibrium is still very unstable. It may help us to foresee the outcome better if we glance at the principal ways in which agriculture has tried to cope with its technical and economic problems.

After the World War, up to about 1932, the chief crop shift was a rapid expansion of specialized wheat and cotton farming in the Great Plains. There was a great increase in the use of tractors in all farm areas adapted to the use of large machinery. In the cities also the internal-combustion engine displaced the horse as a means of transport, and the market for work-animal feeds declined. Farming in certain of the older cotton areas, where the physical conditions restrict the use of large machinery, moved toward more diversified and live-at-home practices. As the number of work animals on farms declined throughout the country, the number of hogs, cattle, and sheep increased. Areas of diversified farming gave more attention to dairying, particularly in the region between the Cotton and Corn Belts.

Agriculture's economic conditions in this period moved relentlessly toward a crisis. Gross farm income was fairly satisfactory from 1924 through 1929; it ranged between 11 and 12 billion dollars annually. But the deductions for taxes, interest, debt charges generally, and production expense were very high; moreover, a disparity existed between farm prices and the prices of the goods and services that farmers commonly buy. In other words, the purchasing power of the farmers was low. Also, the foreign market for agricultural products showed weakness, which became pronounced when the United States stopped making additional foreign loans. After the 1929 crash, farm income dropped sharply; the gross for 1932 was only 5.3 billion dollars.

New Expansion Started

In these circumstances the farmers' power to adjust themselves to their market conditions failed, and the Federal Government had to come to their assistance with the Agricultural Adjustment Act. Cooperative crop adjust-

ment, with unfavorable growing weather working in the same direction, removed the agricultural surpluses, and prices began to rise. But in 1936, following the invalidation of crop control by the decision of the United States Supreme Court in the *Hoosac Mills case*, the acreages of the leading crops increased again. Because 1936 was a drought year, production did not increase; it was evident, however, that the machinery had been started for a new cycle of crop expansion.

Nevertheless by 1937 farmers in the major crop regions had substantially modified their cropping systems in a good way. They had diversified their production considerably, and established a better balance between soil-building and soil-depleting crops. Congress enacted the Soil Conservation and Domestic Allotment Act in 1936, and in that year farmers diverted about 31,000,000 acres from soil-depleting to soil-conserving crops. Most of the diversion was from cotton, wheat, and corn to legumes and other soil builders. Adjustments in different parts of the country were not always in the same direction, or governed by the same motives; but the combined result promised substantial farm improvement. All the major farming regions effected important changes.

Southern Farming Changed

In the Cotton Belt the most outstanding change was a movement away from utter dependence on cotton. With the reduction in the cotton area under the triple-A programs from 1933 to 1936 went a much-needed increase in food, feed, and soil-conserving crops. When the Soil Conservation and Domestic Allotment Act replaced crop control, the movement continued. The 10 principal cotton States had 10,599,000 fewer acres in cotton in 1936 than their annual average in the 5 years 1928–32. Corn-producing sections of the Cotton Belt increased their corn acreage a little, and produced more hay and other roughages.

In consequence they harvested a higher proportion than usual of their corn for grain. Tame hay acreage in the 10 States in 1936 exceeded the 5-year (1928–32) average by more than 2 million acres. Acreage in alfalfa increased by one-third, and the acreage in lespedeza trebled. Plantings of annual legumes increased largely, the acreages in soybeans and cowpeas more than doubled, and a considerable increase took place in the acreage in peanuts. Wheat acreage in the Carolinas, Georgia, and Tennessee, where most of the wheat grown is consumed locally, increased 92 percent. Also, southern farmers grew more sweetpotatoes and truck crops. Feed-crop acreages increased, and the number of cattle and hogs on farms increased. The South's increased production of livestock and livestock products probably will not be directly competitive with the production of the specialized livestock regions, because the South needs more livestock products for consumption locally.

Conditions in the Great Plains

In the wheat-producing regions of the Great Plains the droughts of 1934 and 1936 disrupted the farming system seriously. Crop abandonment was heavy, and livestock numbers dropped to a low level. With livestock thus reduced, the farmers attempted to increase their production of cash grain. Winter and spring wheat seedings in 1936 and 1937 were above the 5-year (1928–32) average, despite unfavorable seeding conditions in large

areas. Acreage reductions started under the original triple-A programs did not persist.

In the southwestern winter wheat producing areas hog numbers dropped more than 50 percent in 1934 and dropped again in 1936. Feed-crop acreages, except grain sorghums and feed sorghums declined. On the other hand, the acreage seeded to wheat increased in 1935 and again in 1936, but abandonment was heavy. In large areas of the Great Plains the prevailing farming methods do not suit the climatic conditions; yet cereal acreage continued to increase.

The Corn Belt

In the Corn Belt hog numbers have not yet recovered from the curtailment that took place after the drought of 1934. In that year and again in 1936 drought destroyed many seedings of clover and timothy, and these have not been entirely replaced. There has been a striking increase in legumes to replace clover and timothy mixtures in the western Corn Belt, Missouri, Illinois, and Iowa. Farmers have increased their production of soy beans for seed; also their production of soy beans for hay and their acreage of alfalfa. Taken together, the increase in the soybean-hay acreage and the increase in the alfalfa acreage practically balance the decrease in mixed-hay meadows. High yielding hay crops will enable this region to maintain its forage production on a smaller acreage. Wheat acreage, which delined in the western Corn Belt prior to 1932, has increased again in certain areas. However, the acreages of barely and oats have declined.

In the eastern part of the Corn Belt (Ohio and Indiana) the corn acreage since 1933 has been about the same as it was in the period 1928–32. Wheat acreage has increased; oat acreage has increased. Alfalfa acreage has increased sufficiently to offset a decrease in the acreage of timothy and clover hay, and the production of soybeans both for seed and for hay has increased considerably. Changes in livestock production have corresponded with these crop shifts. The western part of the Corn Belt in 1936 had fewer hogs than the average for the 5-year period (1927–31) while the eastern part had more. The Corn Belt as a whole had more beef cattle than before the depression, and also more dairy cows. In the north-central dairy States an increase in alfalfa acreage has offset a decrease in the acreage of mixed hay since 1932, and wheat seedings have increased somewhat. The eastern dairy States are producing more corn and more high-yielding hay crops. In both of these important dairy regions the number of cattle and milk cows has increased, though the percentage gain has been smaller than that recorded for the United States as a whole.

Domestic Types of Farming

When unemployment developed after the war, and to an enormously increased extent after 1929, millions of city dwellers sought refuge on the land. Some of them returned to the homes of their relatives; others sought work as farm laborers; and a third group looked about for land on which to grow something for themselves. This whole movement, and the accompanying check to cityward migration, tended to foster a more domestic type of agriculture, and also part-time farming. Even the people who returned to live with relatives strengthened the subsistence-farming principle, because they added to an already excessive farm manpower and could

best occupy themselves in growing things for the farm table. Likewise, there was no commercial demand at the time for more wage labor in agriculture. The increased supply could best be employed in noncommercial production. People who took up land for subsistence farming produced a little for sale, and supplemented their income with part-time nonfarm work. Industrial revival after 1933 checked the movement, but it left a residuum.

Some of the effects appeared in the last agricultural census. Rural population in the depression areas showed the greatest proportionate gain in the noncommercial farming districts and in areas near industrial centers. The number of small farms increased. Their occupants commonly had part-time work in industry. These part-time farmers differed from the part-time farmers of a century or more ago in one very striking respect; they did their part-time work off the farm, instead of in home handicrafts. They went each day, or as often as the opportunity offered, into the nearby factory, and their farming was a supplementary source of income. They constituted a hybrid group not fully identified with either rural or urban conditions.

It remains to be seen whether they will persist as an integral part of our economic system, or will be absorbed completely into urban industry with the full revival of employment. It seems probable, with the growth in motor and highway facilities, that so-called part-time farming will continue near the cities, and will ebb and flow as city jobs become more or less plentiful. The movement should be carefully studied. In periods of severe depression, it will give rise inevitably to serious rural difficulties. So-called subsistence farming does not compete strongly with efficient commercial farming; but when the urban connection fails, and the subsistence farmers can get no part-time nonfarm work, it results in rural distress.

Movement of Urban Families

Similarly, the movement of urban families to points distant from the industrial centers, where they settle inevitably on the poorer land, creates a difficult social problem. Such families commonly know little about agriculture. They long chiefly for security, and think to find it on a few acres of any description. Often they find they have jumped out of the frying pan into the fire. Even when a city family gets hold of a reasonably good farm its troubles are not over; for the family may lack sufficient experience or capital. Moreover, the better the farm, the more it becomes a commercial rather than a subsistence farm unit; and commercial farming is a job for experts. Under favorable conditions so-called subsistence farming may cushion the shock of industrial depression, but it seldom furnishes the desired economic security, and seldom builds permanent homes. Moreover, those who resort to it may find, after a few years, that they have lost their knack for industrial work.

Side by side with the subsistence-farm movement, which from the purely economic standpoint is a reversion to an earlier and less efficient type of agriculture, the depression period has emphasized the importance of mechanization and the larger scale farm operations. These opposite trends produce certain obvious difficulties. As the mechanization of the better situated and more productive farms proceeds, the problem of using the poorer land efficiently, and of making a niche in the agricultural system for

the unmechanized farm unit, is more difficult. Invention and science tend increasingly to benefit one group of farmers and to handicap another. Between 1920 and 1930 the number of tractors on farms increased from about 250,000 to nearly a million, and in the same period the number of horses and mules on farms dropped by about 6,000,000 head. Between 1930 and 1937 the number of horses and mules declined further. After 1934 the resulting need for farm power gave a new stimulus to the mechanization of agriculture, and sales of tractors increased again.

Mechanization Again Increasing

The trend toward greater mechanization in agriculture has been resumed, particularly in the Corn Belt and in parts of the Eastern States. Tractors are becoming more numerous in the South, though they are still not yet common there. The development of the general-purpose tractor, and particularly of the small machine of this type, has been a powerful new influence. Wheel tractors with pneumatic tires extend the list of field operations that can be done with engine power, and manufacturers are producing suitable tillage and harvesting equipment. With the latest inventions, many farms not formerly considered well suited to mechanization prove well adapted to it. The small combine is revolutionizing harvesting methods, not only in the Great Plains, but in the more humid sections. On quite small farms it successfully harvests small crops such as soybeans. When the wreckage left by the depression has been cleared away, American agriculture will probably be more extensively mechanized than it was before.

Movements of Population

After a sudden reversal during the depression of trends that had been fairly constant for many years, movements of population between town and country in the United States returned to their normal course. In other words, the farm population began to decline. There were 80,000 fewer people living on farms January 1, 1937, than on January 1, 1936. Prior to 1930 the net migration from farms to cities and towns, or the excess of the cityward movement over the farmward movement, was large, and the total farm population declined. In 1932 there was a net migration of 266,000 persons to the farms. This addition to the farm population, with the usual excess of farm births over deaths, gave a net gain for that year of 722,000 persons. By 1936, however, the tide had begun once more to ebb away from the farms. In 1936 there was a net migration away from farms of 447,000 persons. Because of the continued large excess of births over deaths on farms the net loss of farm population, as already mentioned, was only 80,000. But the farm birth rate is declining, technical progress in agriculture continues to reduce the amount of manpower necessary, and industry shows signs of providing an increased number of city jobs. Therefore it is probable that, for the next few years at any rate, the downtrend in the farm population will continue.

COSTS OF MARKETING

Recent studies of the Bureau of Agricultural Economics show that about half the consumer's food dollar goes to pay marketing costs. For 12 important fruits and vegetables this cost of distribution in 1936 averaged 60

percent of the retail value of the products. It is imperative that more attention should be given to the improvement of the marketing system. The Department of Agriculture has established market news and grading and inspection services for most of the important farm products. Congress has enacted marketing legislation, including the Packers and Stockyards Act, the Cotton Futures Act, the Produce Agency Act, the Perishable Agricultural Commodities Act, and various acts dealing with warehousing, packaging, etc. These services and laws are mainly to improve marketing practices. But the system itself is defective. It should serve the farmer and the public better. Marketing agreements under the A. A. A. have brought about more orderly marketing, particularly from the farm. But public agencies have done little to improve methods of city wholesaling, jobbing, and retailing, except to suppress certain dishonest practices.

The proportion of the consumer's food dollar that goes to the farmer varies considerably from one kind of food to another. It amounts to only about 10 or 15 percent of the retail price of such highly processed foods as crackers and canned fruits, whereas the average is more than 60 percent of the retail price of eggs. Whenever food prices rise, the spread between the price the farmer gets and the price the consumer pays attracts more attention. Interest in this spread was very strong in 1933 and 1934, in which years prices rose sharply both on the farm and in the city retail stocks. It became strong again in 1937. The prices of certain foods, particularly meats, went up rather sharply from 1936 to 1937, mainly as a result of the great droughts of 1934 and 1936, which greatly reduced the supply of feeds and of meat animals. Many farmers and consumers believed that packers and retailers were taking advantage of the situation to increase their charges. It is difficult to determine the truth. Different sets of price data give conflicting results. There is need for more detailed study of the question, and the Bureau of Agricultural Economics has begun such a study in connection with its general investigations of marketing and distribution costs and charges. Some of the increase in the marketing bill in 1937 was the reflection of increased wage payments by processors, handlers, and distributors. There is no doubt, however, that our marketing system could be improved in such a way as to reduce the spread between town and city prices.

Wholesale and Jobbing Markets

Some recent studies of city wholesaling and jobbing markets for fruits and vegetables indicate real possibilities for reducing distribution costs of farm commodities. In many cities the markets are very old, and commonly have undergone little change in 50 years. Since these markets were established many social and economic changes have taken place. The population has increased manyfold; methods of transportation have changed from water and wagon to rail and motortruck; produce from distant producing areas has become available throughout the year; consumption per capita has increased. Yet the markets have undergone little change. Many of them, new as well as old, are improperly located, designed, and equipped.

In many cities expanding business and unsatisfactory marketing conditions have led to the establishment of competing markets. Often the new markets perform the same functions as the older ones, and have little better equipment. Railroad companies have built modern produce terminals,

separate from the regular wholesale markets, and have restricted their use to produce arriving by rail over their own lines. Then other railroads have built competing terminal markets to handle produce arriving over their lines. Much money has been wasted in thus providing unnecessary and duplicating facilities. This splitting of business among many markets scattered throughout a city usually means that no one market handles a complete line of commodities. Buyers must spend from 12 to 15 hours in going from one market to another to obtain supplies. There is unnecessary cross hauling and spoilage. Operation expense increases. It becomes almost impossible to get timely information on supply, demand, and prices. Regulations of hours and other regulations cannot be enforced and the markets fall into demoralization.

Facilities Often Inadequate

Besides being antiquated, improperly located, badly designed and equipped, and poorly coordinated, markets in many cities have no adequate facilities for handling receipts by truck, and traffic congestion results. In few cities is it possible for fruits and vegetables to be unloaded directly from railroad cars into the wholesale market. A truck haul, frequently through heavy traffic, is usually necessary. This is true even in new markets. Unregulated selling hours and lack of information on supplies are additional handicaps.

The Federal Trade Commission pointed out the seriousness of the situation in a report to Congress on June 10, 1937. This report described many unsatisfactory conditions in the marketing of fruits and vegetables, and concluded that improvement calls for action on a large scale and that "each of the principal terminal markets should be studied." In bringing about improvements in any city three steps are necessary: (1) Research to determine needs; (2) construction or reorganization; and (3) operation.

The first prerequisite of any effective plan for improving markets is a very careful study of local conditions to determine needs. Haphazard developments not based upon a definite plan cannot succeed. Many mistakes have been made because facilities have been provided without the proper preliminary study. Such mistakes not only lead to unnecessary expenditure in providing facilities, but frequently establish a marketing system that is highly inefficient and expensive to operate.

Research should be carried on by agencies that are familiar with local conditions and are competent to analyze the problem. It is imperative, however, to study the situation with a view to general market efficiency, rather than from the narrower viewpoint of some special interest. Marketing facilities and methods in the larger terminal markets present problems the solution of which is important not only to nearby producers and consumers but to distant producers. This Department glady cooperates with local research agencies in studying the possibilities of improving terminal markets.

Plan of Public Control

After a proper plan has been developed for improving the markets of a city, the next task is to put it into effect. There is a definite advantage in having only one wholesale market in all cities except the very largest;

indeed, a wholesale market may be considered a natural monopoly. Therefore in the provision of these facilities the produce trade and the public need protection from improper monopolistic practices. This involves some degree of public control. It may be slight or may extend to actual public ownership and complete regulation of methods and charges. New York State has recently provided for so-called market authorities. These are corporations which have the authority to buy or otherwise acquire land and to construct market facilities with funds borrowed for that purpose. The possibilities of interstate or Federal market authorities should be studied.

In some cities there is no need for the construction of a new market; the problem is largely to reorganize the existing markets into a unified system. This is often very difficult. Even when a satisfactory plan has been worked out, action may lag; because any worth-while reorganization will reduce costs, and that will mean a loss of income by certain people or interests. Any worth-while reorganization plan will certainly encounter strong opposition. Generally it should be possible eventually to conciliate the conflicting interests and accomplish any necessary reorganization cooperatively. But when marketing conditions are very bad, and reform cannot be obtained in this way, it may become necessary for some governmental agency to assume the leadership.

With marketing costs in many cases as high as production costs, there is as much justification for the study of marketing and markets as there is for the study of production. It is perhaps more difficult in marketing than in production for individuals to work together in making fundamental changes, and collective action is virtually indispensable. Public agencies may usefully conduct preliminary research to be prepared for any action which may be thrust upon them in the future. Conditions have reached the point where improvement in marketing is overdue, and this Department is seeking ways of accomplishing it.

GRADING AND STANDARDIZATION

Revised standards promulgated last year for grain and cotton are now being used on the markets. They were shaped to meet the needs of changing production, processing, and marketing practices, and to utilize new knowledge about these commodities. The revised standards for cotton, which have been in effect practically throughout the year, fit the crop well and have been found generally satisfactory; likewise the revised grain standards for flint and dent corn. The standards for wheat became effective October 1, 1937.

The Tobacco Inspection Act of 1935 provides that upon favorable referenda by the growers, the Secretary of Agriculture may designate auction markets for free and mandatory inspection service, coupled with market news service. Under its terms 23 auction markets have been designated, and the service was in operation on all but 3 of these during the fiscal year 1937; an injunction halted the service on 3 markets. On the remaining 20 markets, a total of 146,113,980 pounds of tobacco was officially inspected during the past marketing season. Other tobacco inspections raised the total for the year to 152,607,344 pounds and present indications are that this amount will be materially exceeded during the present fiscal year.

An important service that is being furnished to growers in connection with inspection and market news is the demonstration of proper methods of sorting tobacco and preparing it for market. The object of this service is to reduce the large volume of tobacco that goes to market each year so poorly handled as to be a source of loss of revenue to growers. In carrying out the demonstration idea, representatives of the Bureau of Agricultural Economics furnished instruction directly or indirectly through agricultural teachers and others to 36,732 tobacco growers during the fiscal year, compared with 10,298 during the preceding fiscal year.

Commodity Standardization for Consumers

Special attention has been given in the Department's standardization work to the needs of consumers, which are often different from those of farmers, dealers, and processors. The possibility of promulgating consumer standards for butter has been considered at a series of hearings. Definite conclusions on the consumer grades have not yet been reached. Also, the Department has studied the possibility of bringing about a closer correlation between the grades of the Federal standards for meats and consumer preferences as measured by such factors as palatability, tenderness, and appearance. Federal meat grades are now used by consumers to a considerable extent, through the medium of the Federal meat grading and stamping service.

Federal standards and commodity certification have been integral parts of our agricultural structure for a decade. The common language they establish among buyers and sellers, for the expression of gradations in the quality of farm products, are basic to satisfactory marketing under modern conditions. Federal standards, inspection services and certification, and market news services, have widened the market, reduced merchandising risks, improved market ethics, and facilitated trading in futures.

Restraints on Interstate Shipments

The founders of the Republic did not explain or define interstate commerce. Many legal decisions have dealt with the subject, without clarifying it finally. Broadly, the Supreme Court sets aside State statutes found unduly to burden, restrict, or hamper the free exchange of goods and services between the States. In some cases it upholds the rights of the States, when they have passed laws dealing with phases of interstate commerce concerning which Congress has taken no action.

Our system of Government does not contemplate a no man's land between Federal jurisdiction and State jurisdiction. When the Federal Government fails or declines to take action, State governments may pass and enforce laws within their own boundaries; but these laws may become null and void if Congress later passes national legislation on the same subject. In recent years many States have enacted laws well calculated to restrict and burden interstate commerce in fresh fruits and vegetables. State legislation for agriculture has gone further along this line than State legislation for manufacturing industry.

Few of the State statutes, even of the more extreme type, interfere greatly with interstate trade. Legal advisers of the State governments have frequently counselled against a policy that might bring the legislation before the United States Supreme Court. Interesting examples exist, however,

of what may be called selective enforcement. This affects only certain products largely produced within a State, or competitive products shipped into the State during its own marketing season. Sometimes there is enforcement of the law only in parts of a State, or under conditions that permit the collection of enough fees to make the enforcement self-supporting or financially profitable.

Frequently such legislation owes its origin to propaganda directed by influential groups. Such groups have commonly felt that requirements and practices with which they were themselves already complying could properly and easily be enforced against outside products. In some instances, however, attempts at the enforcement of such legislation have shown that the sponsors of it were not meeting their own requirements. As a result, laws rigorous in their wording have become ineffective in practice. Indeed, effective and efficient enforcement of all existing State laws that pertain to labeling, grading, tagging, marketing, and standardization would disrupt or paralyze interstate trade. Shipping organizations would have to sue for a determination of their rights, and the whole question would suddenly become national. In some States legislation imposes extraordinary restrictions on interstate commerce in fruits and vegetables, and only the fact that it is not rigorously enforced prevents the situation from becoming intolerable.

Legal Status of Border-Line Activities

The legal defense of many State border-line activities would seem to be difficult. For example, merchants who receive shipments by truck find their products detained for remarking, regrading, or restandardization, while identical products entering the State by railroad meet with no similar interference. In some of the State laws that interfere with interstate shipments of fruits and vegetables, the language obviously conflicts with the constitutional right of Congress to regulate interstate commerce. Some States have laws which, if literally interpreted and enforced, would make it necessary for all shippers to show the United States grades on their shipments. These laws strengthen the hands of certain large producers within the States in question, not only against outside shippers but against their less well-equipped fellow citizens.

This policy, which a State executive described as the exchange of irritations with neighboring States, does much harm. It raises a number of fundamental questions. Commonly the imposition of border-line restrictions on the interstate movement of fruits and vegetables hampers the sale of wholesome products which must be sold chiefly to the poorer people. Is it a proper State function to burden the sale of products that are necessarily cheap and to give better treatment to the products that command higher prices? It is very objectionable to halt shipments over the highways without imposing similar requirements on railroad deliveries. In certain aggravated instances the conditions have been declared to approach a state of border warfare.

Danger to Free Trade in United States

This country's high standard of living results partly from the fact that it is the largest free-trade area in the world. Nowhere else have the products of nature and of man been so widely and so freely interchanged. This is a major blessing, which we should not jeopardize. We should not erect

barbwire entanglements across the highways of our internal commerce, or dig pitfalls in the paths of interstate communication. In the long run, the States that think to gain by such a policy will lose; for they have to send out shipments as well as to bring shipments in. Monopoly practices with regard to inward shipments will lead to retaliatory practices in other States, and bring about what might be called regulation by retribution. This is the worst possible kind of trade regulation.

THE COMMODITY EXCHANGE ACT

The Commodity Exchange Act (approved June 15, 1936) strengthened and expanded the Grain Futures Act, and added six commodities to those previously under market supervision. Its object is to promote fair practices and honest dealing on the commodity exchanges, and to provide a measure of control over speculative activity, which often demoralizes the markets. Already the new legislation has brought about a more adequate supervision of trading in commodity futures, and furnished better protection to all legitimate interests.

In the fiscal year 1937 the aggregate volume of the trading in all grains and flaxseed was 16,577,003,000 bushels. This was an increase of 50 percent over the total for the previous fiscal year. All the grain futures showed substantial percentage increases: Wheat futures increased 35; corn 110; oats 130; rye 59; and barley 39 percent. On the other hand trading in flaxseed futures dropped from 17,142,000 bushels in the fiscal year 1936 to 8,141,000 in 1937. Needless to say, increased trading in futures does not of itself reflect a proportionate change in the economic condition of the country. It tends, however, to increase with improvement in general economic conditions, and as it does so it adds to the responsibility and the work of the Commodity Exchange Administration.

The dollar value of the trading in the 13 commodities now covered in the Commodity Exchange Act has been estimated, for the 10-year period 1927–36, at an average annual total of more than $25,000,000,000. There are no official figures for the trading in futures of cotton, butter, eggs, potatoes, and millfeeds. However, the exchanges give data on the volume of the transactions. Official figures are available for grains and flaxseed. Combining the two sets of data gives the approximate figure above mentioned. There is no doubt that the total for the fiscal year 1937 will run well above the 10-year average; for business conditions are better and agricultural prices higher. In 1938 official statistics will be available covering purchases, sales, and open contracts in all the commodities mentioned in the Commodity Exchange Act. This information is essential to the efficient supervision of the exchanges, 16 of which have met the requirements of the law and obtained the right as contract markets to trade in specified commodity futures. They cooperate readily with the Commodity Exchange Administration, and invite its representatives to attend the deliberations of their business conduct committees.

Requirements of Contract Markets

Essentially, the requirements of a contract market under the Commodity Exchange Act are six: (1) It must be located at a terminal market where the commodity is handled in cash sales; (2) it must agree to supply the

Secretary of Agriculture with detailed reports of its transactions; (3) it must endeavor to prevent the dissemination of false or misleading crop and market information; (4) it must agree to prevent market manipulation and corners; (5) it must agree to admit cooperative associations to membership; and (6) it must deny trading privileges to persons who have violated the law. Commission merchants and floor brokers must register with the Secretary of Agriculture. Some have not yet registered, and they render themselves liable under the criminal provisions of the Commodity Exchange Act.

There is a Commodity Exchange Commission composed of the Secretary of Agriculture, the Secretary of Commerce, and the Attorney General. This commission has power, after giving due notice and an opportunity for interested persons to state their views at a hearing, to set limits for the speculative trading that may be done on contract markets. It may determine the maximum amount of business any individual may transact during a business day, and may set a limit on the net long or net short position of any person in futures trading. It is improbable that such limits will be hastily applied, and in any event they will not be applied until public hearings are held. In emergencies or unusual circumstances, however, it may be imperative to act; for speculative trading at times has an unduly disturbing influence on the commodity markets.

It may be well to observe that the Commodity Exchange Act is not a guaranty of high prices for agricultural products, nor an assurance of a ready market for them at all times. It simply provides a measure of restraint over fraudulent and manipulative practices, and facilitates the maintenance of fair and honest farm-commodity exchanges.

Congestion in September Corn

Serious congestion developed in the 1937 September corn future. It resulted in the suspension of trading in that future on the Chicago Board of Trade after September 24, 2 days before the trading would normally have ceased. The directors of the board established a settlement price of $1.10½ a bushel.

Radical variations from the normal trend occurred in this future. The daily price range was excessive, and the volume of trading abnormally large. The usual relationship between open commitments and the visible supply of corn was upset. This situation was made possible by the fact that the carry-over from the previous year, when drought reduced the corn crop, was the smallest since 1900.

One trader on the long side and two on the short side dominated the September future. At one time during September the principal long account held or controlled a maximum of 74 percent of all the open commitments on the long side. At about the same time the two principal short accounts held a maximum of nearly 29 percent of all the open commitments on the short side. No other individual account on the short side amounted to as much as 1 percent of the total. The result was a stubborn struggle between the opposing interests. They refused to settle their contracts except on profitable terms.

Two months before the expiration of the September corn future, the Commodity Exchange Administration pointed out to the Chicago Board of Trade that there was a possibility of congestion in it. Corrective steps

taken by the Commodity Exchange Administration and the Board of Trade, from August 1 until September 24, restricted price movements somewhat and kept the market from becoming completely disorganized. The Department made an investigation to determine whether or not any traders actually engaged in manipulative operations, and whether or not the Commodity Exchange Act had been violated. Limitations probably will be fixed on individual traders' speculative commitments in the near future under the authority contained in section 4a (2) of the Commodity Exchange Act. The Department also contemplated exercising the authority contained in section 5a (4) of the act to extend the period in which delivery may be made on a futures contract after trading in the future has ceased.

Whenever a good crop follows an unusually short crop, there is opportunity for a situation to develop like that in September corn in the year 1937. The month when it is most likely to develop is the one at the close of the short-crop season and just before the large-crop season begins. Commodity exchange regulations can help in part to avoid such situations, but, fundamentally, the cure is to be found in a practical form of the ever-normal granary which will supplement the low supplies of corn in years of serious drought so as to prevent shortages at the end of a drought season such as occurred in the summer and early fall of 1937. The speculative system, no matter how well it is run, cannot cope adequately with the wide fluctuation in supplies caused by excessive variations in the weather.

WEATHER CONDITIONS AND SERVICES

After the severe drought and high temperatures of 1936, substantial rains came during the latter part of August, and relieved droughty conditions over many northern and eastern sections of the country. The moisture benefited late crops, revived pastures, and improved the condition of the soil for plowing and for seeding of winter grains.

Extremes of both temperature and precipitation occurred in parts of the country in January 1937, with resulting floods in the Ohio Valley, and freezes in the far West. Exceptionally warm weather prevailed in the more eastern States. The spring began with plenty of moisture in the soil nearly everywhere east of the central Great Plains—too much in places. Snows in the higher western mountains provided ample moisture for summer irrigation. The greatest snowfall reported for the period from December to April was 642 inches at Paradise Inn, Wash.

For the 3 spring months (March–May) rainfall was much heavier than during the spring of 1936 throughout the Mississippi and Ohio Valleys and in the northern Great Plains. But a belt extending from eastern New Mexico and western Texas northward to Canada had very little precipitation. By the middle of May severe drought prevailed there. Heavy rains came in the area toward the end of May and in the first part of June, and these gave temporary relief; but a generally dry period followed. Rain was again needed in most of the area during the summer.

For the summer (June-August) temperatures were mostly above normal, with July and August abnormally warm in Midwestern and Northwestern States. However, temperature abnormalities were not nearly so great as during the extremely hot summer of 1936.

East of the Mississippi River rainfall for the summer season ranged from near normal to considerably above normal in all States except Wisconsin. However, between the Mississippi River and the Rocky Mountains, moisture was scanty in many places, especially in the western Great Plains, where last year's drought was so severe. West of the Rockies most States had above normal rainfall. In general the crop-growing season of 1937 had favorable weather, except in the Great Plains, where drought the latter part of the season damaged pastures, corn, and other summer crops.

The early fall of 1937 was favorable for maturing crops of all kinds and for harvesting and there was no serious frost damage. East of the Mississippi River conditions in September were mostly favorable for preparation of soil and the seeding of winter grains, but the continued lack of rainfall in the western winter wheat belt was decidedly unfavorable. The first half of October brought helpful rains to the northern and also the southern plains, but central sections continued badly in need of moisture, with unfavorable dryness extending as far east as Missouri and Iowa.

The Floods of 1937

Record-breaking floods occurred in the Ohio and lower Mississippi Valleys in January and February 1937, as a result of a prolonged period of heavy to excessive rain. This began on December 26, 1936, and continued with little interruption until January 25, 1937. Persistent high pressure over the Bermuda-Florida area and also over the Northwestern States, with a trough of low pressure between them over the Ohio Valley, caused an almost continuous northward and northeastward movement of great quantities of moisture-laden tropical air over the lower Mississippi and Ohio Valleys. Meanwhile air masses of polar origin moved southward, almost continuously, over much of the western half of the United States. The line of contact between the warm moist air from southerly regions, and the cold air of polar origin, lay somewhere over the Ohio Valley much of the time. The rapid forcing aloft of the moist air of tropical origin resulted in excessive precipitation over an area, the major axis of which closely paralleled the Ohio River.

Accumulated snowfall was not a contributing factor, though this was a midwinter flood; practically all of the water came from current rain. The ground was thoroughly saturated, and lack of vegetation contributed to maximum run-off. The rainfall was sufficient during the first half of the period to put the lower Ohio and its lower tributaries into moderate flood. Flood stage on the main stream was reached first at Cairo, Ill., on January 9; at Evansville, Ind., January 10; and at Cincinnati, Ohio, January 18. From January 13 to 24, inclusive, the rainfall was exceedingly heavy, with the area of greatest intensity along the Ohio River from Cincinnati to its mouth, and extending somewhat south of the river mouth into Arkansas.

River stages were the highest of record in the main stream from immediately below Point Pleasant, W. Va., to the mouth at Cairo, Ill., and in the lower Mississippi River from Cairo to the mouth of the Arkansas River. At Cincinnati the crest stage of 80 feet was 8.9 feet higher than the crest of the great flood in February 1884 which had stood as the record stage at that point for more than 100 years. At Louisville the crest was 10.4 feet higher than the record stage in that year. Record-breaking stages occurred

in the lower portions of many Ohio tributaries, while in the upper reaches flood stages did not occur. Moreover, the high stages were of long duration. The river remained above flood stage at Cairo and Paducah 48 days; at Evansville, 39 days; at Louisville, 22 days; and at Cincinnati, 17 days. In the upper reaches of the river the fall was rapid after the passage of the crest, but much slower in the lower portions.

Flood forecasting by the Weather Bureau functioned efficiently. River-stage forecasts and flood warnings were issued regularly and given wide distribution. They were relayed to the national headquarters of the American Red Cross, for use in planning relief activities. Above Cincinnati the river ceased to rise within 30 hours after the rain ended. Below Cincinnati accurate final crest-stage forecasts were issued for extended periods ranging from 3 days at Louisville, 6 days at Evansville, 9 days at Cairo, and 14 days at Memphis, to 31 days at New Orleans.

Frost Warnings and Orchard Heating

The freezes of January 1937, which broke all records for low temperatures and duration of freezing weather in southern California, afforded an opportunity for a remarkable demonstration of the effectiveness of orchard heating. Despite utterly inadequate storage of heating fuel, the damage to crops and trees was extremely small as compared with that in previous freezes far less severe. In groves properly equipped for heating, the damage was negligible. In districts where a large percentage of the orchards were adequately heated, the scattered intervening orchards not equipped with heaters received protection from the neighboring heated groves, and showed little or no damage. This "mass heating" was the outstanding feature of the experience.

Damage to the trees was confined almost entirely to districts in which there was little or no orchard heating, and to orchards located on the windward fringes of well-protected districts. The heaviest damage occurred in sections normally warm, in which protection had been considered unnecessary. Normally colder areas, well equipped for protection, suffered practically no injury. The lowest temperature recorded in a citrus grove, 13.5° F., was in a district normally warmer than the average in which there were no orchard heaters. In an unprotected grove in a normally colder district, in which approximately 90 percent of the orchards were heated, the lowest recorded was 20.3°. This showed the effect of mass heating. Growers burned approximately 81,900,000 gallons of oil during the freezes at a cost of about $4,000,000. Growers who saved their crops actually profited by the freeze, because the resulting better prices for sound fruit more than paid the heating costs.

Warnings well in advance of the freezes facilitated the transportation of additional heater-fuel to the citrus districts. Fuel supplies ran low before the end of the cold period, and a few growers who had spent large sums for protection lost their crops on the last night for want of fuel. However, the freeze warnings of the Weather Bureau prevented a general catastrophe. They saved sufficient fruit in one night to pay the cost of the horticultural protection project for a generation. (Users of the service pay about one-half the cost. This insures local interest, and guards against the continuation of the work in any district where its practical value is not demonstrated continuously.)

Citrus growers in Florida experienced a disastrous freeze in December 1934, and the Federal Government and the State of Florida afterwards established a cooperative horticultural protection service in that State. Five protection districts were organized in the west-central portion of the peninsula, where there is a heavy concentration of citrus plantings. Localized minimum temperature forecasts and other essential information were broadcast last winter during the frost-danger period several times daily, on a staggered time schedule, by networks of commercial radio stations. Funds have been provided to extend the service. This winter most of Florida will be covered.

Effective measures of frost control require large expenditures for grove-heating equipment and fuels, and the services of much additional labor. They necessitate organization and preparedness. The whole frost-fighting machine must be brought into action promptly and must remain alert until the danger is past. The weather is the sole factor involved. Detailed forecasts of temperature at numerous stations spread intensively over local areas are therefore indispensable.

Methods of Frost Protection

As a means of frost protection, citrus growers in California began to burn coal in crude baskets, made of chicken wire hung in the trees, as early as 1897. The Weather Bureau started its horticultural protection service in 1917. By that time oil-burning heaters had largely replaced heaters designed for burning solid fuel, but frost-protection methods had progressed but little along other lines. Cheap, inaccurate thermometers, heaters without capacity to burn through the night, oil containing an excess of asphaltum, water, and sulphur, lack of knowledge of critical temperatures, ignorance of the principles of orchard heating, and, most important of all, lack of detailed, accurate temperature forecasts, had caused many failures, and brought orchard heating into general disfavor. The acreage equipped with heaters was declining.

After a period of experimental work, the Bureau designed new types of thermometers for orchard-heating operations. These became available at reasonable prices through growers' cooperative purchasing agencies. Experts checked them for accuracy at the beginning of each frost season, and explained the principles of orchard heating at meetings and in articles and bulletins. Experiments proved that smoke, which had been credited with saving crops, was of minor importance. Critical temperatures for various fruits, buds, and blossoms were determined, and temperature surveys made in different fruit districts to show the locations of colder and warmer areas on frosty nights. Demonstrations exploded the belief in "frostless belts." Studies were made on the influence of cover crops on orchard temperatures, and the frost marking of pears and apples.

Fire-Weather Service

The Weather Bureau expanded its forest fire-weather service during the fiscal year. It added new mobile forecasting units at Mount Shasta, Calif., Portland, Oreg., Seattle, Wash., and Missoula, Mont. These four units, with one provided by the Forest Service previously in southern California, extended the fire-weather service to all western districts, and

covered the principal forests (Government, State, and private) of California, Oregon, Washington, Idaho, and western Montana.

Mobile forecasting units do not replace the service which had been given heretofore. They provide an additional aid in the control of forest fires. Service from the mobile units helps in fighting particular fires. The forecaster moves his facilities to the scene, and keeps in touch with the fire fighters, so that he can warn them immediately of any significant change in weather conditions. Essentially the mobile unit is a portable meteorological office built into a standard truck chassis, and provided with observing, charting, and communication facilities. It is manned by a forecaster and a radio operator. Weather information and forecasts are always of high value, and frequently vital, to fire fighters. Knowledge as to the force and direction of the winds is of particular importance.

Hurricane Warnings and Cold-Wave Studies

By an inspection of meteorological stations in the Bahamas, the Bureau strengthened the hurricane warning service. Reports from some of these stations come daily to the Weather Bureau; reports come from others in the group when a storm is in the vicinity. The accuracy of the reports is vital in forecasting storms that approach the Florida coast from the east. The inspection was arranged through cooperation with the Government of the Bahamas. and carried out by use of a United States Coast Guard seaplane. An official of the Weather Bureau visited 14 of the 20 meteorological stations on the islands, checked their equipment, replaced defective instruments, and installed additional equipment where it was needed. Stations favorably situated for the purpose arranged to furnish reports of tide and swell.

With an allotment from a special research fund provided by the Bankhead-Jones Act, the Weather Bureau started an investigation of cold waves in North America in cooperation with the Canadian Meteorological Service, the Massachusetts Institute of Technology, and the Bureau of Agricultural Economics. Cold air masses form from warmer air in the far North during the Arctic winter, by the upward propagation of radiational cooling over the snow-covered continent. Eventually an outbreak occurs in the form of a cold wave which sweeps southward over Canada and the United States.

Detailed observations were made of meteorological conditions during the development and subsequent outbreaks of cold air. Airplane soundings, terrestrial radiation measurements, and snow-surface temperature observations at Fairbanks, Alaska, Fort Smith, Canada, and Fargo, N. Dak., provided important data. Statistical and theoretical studies at the central office dealt with the physical processes of the formation of the cold-air masses, and the dynamical mechanism of their southward release and propagation. This work, which will be continued another year, should improve the accuracy and extend the range of cold-wave predictions. Improvements in the technique of air-mass analysis helped the forecasters at the central office of the Bureau in Washington.

Farmers have been looking for years for long-range weather service, but very little progress has yet been made along this line. The just-mentioned observations now going forward in the North may furnish answers to some questions. Light on the problem of long-range weather forecasting may come also from the study of the Weather Bureau's records,

which go back for 50 and in some cases 100 years. Study of these records may indicate some of the basic forces in the formation of the weather, and provide some key to long-range forecasting. It seems clear, from studies already made, that the records contain clues to the laws of the weather. As yet, however, the Weather Bureau, while it has an open mind concerning theories of long-distance weather forecasting, has found no reason to put much faith in any of them.

Weather Reports for Aviation

The large increase in the cruising speed, and in the volume of air traffic during the past few years, have required an expanded meteorological service for the airways. Approximately 120 stations have been added to the network to furnish complete reports every 6 hours, for use in preparing weather maps and airway forecasts. Along airways not equipped with teletype and radio, the Bureau has established a system that provides for the collection of one report about an hour prior to the departure of each scheduled flight, and another just before the departure. Instrumental equipment has been improved at a large number of important stations. About 780 stations now make reports for air traffic over approximately 33,000 miles of airways in the United States, Hawaii, and Alaska. At 52 airport stations, Weather Bureau personnel render 24-hour service.

RESEARCH IN PLANT INDUSTRY

All agriculture is based upon plant industry. Crops may be used directly as human food, they may be fed to livestock as pasture, forage or concentrates, or they may be utilized in manufactures. Plant research endeavors to improve the quality of products for their appropriate use, to maintain the possibility of efficient production in spite of the hazards of weather, insects, and diseases, and to diminish losses in storage and transit. Results recorded here are primarily of an immediate practical nature. All research, however, has practice as the ultimate goal. Much of the Department's plant research aims to discover the underlying principles of plant genetics, physiology, and pathology. It is obtaining fundamental information, the use of which will be reflected in practical applications in years to come.

The higher levels of fertility obtained by the application of commercial fertilizers, together with good farm-management practices, result in higher yields of corn, but also promote an increase in corn diseases in many of the commercial varieties of corn. This has been demonstrated in tests conducted by the Bureau of Plant Industry in cooperation with the Illinois Agricultural Experiment Station. Recently, hybrids have been discovered that give high yields of sound grain under conditions of high fertility, where commercial varieties show excessive injury from stalk and ear rots.

Outstanding yields have been obtained from certain corn hybrids in tests in some of the drier sections of the Corn Belt. These hybrids should reduce crop hazards. Hybrids entered in the Iowa yield test outyielded the standard commercial varieties by 30.8 percent—about twice the usual percentage increase. The increase was nearly as great in the Illinois corn performance test. Hybrids developed in cooperation with the Iowa Agricultural Experiment Station placed first in five of the eight sectional classes of the State test. Many outstanding hybrids are now in commercial production. About

3.5 million acres of hybrid corn were grown commercially in 1937. Wide differences exist in the relative attractiveness to grasshoppers of different inbred lines and hybrids of corn. This was demonstrated in corn-breeding plots in Kansas and Illinois, during a severe outbreak of grasshoppers. In some cases where different strains were grown in adjacent rows, one strain was entirely defoliated before the other was damaged appreciably. Whether this can be put to practical use, remains to be determined.

Wheat Bunt Findings

In a cooperative study with a number of the State experiment stations, the Bureau found that about 65 collections of wheat bunt from different sources included 20 distinct races of economic significance. Crosses of varieties of wheat have been made to combine the resistance of all these races into a single variety. Such a variety has been isolated from the crosses made with winter wheat, but not as yet from those with spring wheat. Study of the prevalence and distribution of the various races of the bunt organism revealed the largest number in the Pacific Northwest. Hymar is highly resistant to the races of bunt most generally prevalent there. One race has been found only in the durum wheat area of the upper Mississippi Valley. Another has been found only in Kansas. So far only a few races have been found in the eastern United States. The breeding of bunt-resistant varieties has produced important results.

Investigators discovered, not long ago, that sulphur inhibits the injurious effects of selenium on plants growing in water or in soil cultures in the greenhouse. They found subsequently that excess phosphate tends to inhibit arsenic injury; that potassium inhibits injury from rubidium; and that calcium tends to reduce the injury from strontium and barium. Toxic concentrations of some of these elements occur occasionally under field conditions, and the newly discovered relationships will undoubtedly have a practical application

In cooperation with the Kansas Agricultural Experiment Station, the Bureau developed a new red oat (Kans. No. 6138) from a Fulghum × Markton cross. It has outyielded Kanota, the standard variety in Kansas, by an average of 9.5 bushels per acre in the past 6 years. It has also exceeded Kanota in test weight. The new strain had an average smut infection of less than 1 percent, compared with 25 percent in Kanota. It is now being increased for distribution to Kansas farmers. Satisfactory yields of oats of excellent quality have been obtained from many new hybrid selections grown in the cooperative experiments at the Iowa Agricultural Experiment Station in 1936. Reselections from a Fulghum (winter type) oat selection (C. I. 2499) have been outstanding in winter resistance at different experiment stations in the South. Two or three of the selections apparently are the hardiest winter oats so far developed.

Drought-Resistant Crops

Sooner milo, an early drought-resistant variety developed by hybridization at the Woodward, Okla., field station, and first distributed in 1930, again demonstrated its value under severe drought conditions in the dust bowl region. This variety, with two similar strains of the variety that were later developed in Texas, produced most of the sorghum grain that was

harvested in drier portions of the dust bowl during the past three seasons. Kalo and Early Kalo, two new grain sorghums developed in cooperation with the Kansas Agricultural Experiment Station are now being distributed in western Kansas. Their early maturity, drought resistance, and general adaptation to the northwestern portion of the grain sorghum region have made these two varieties very popular in western Nebraska where they were distributed in 1935.

Club, a new variety of grain sorghum selected from kafir at Hays, Kans., in cooperation with the Kansas Agricultural Experiment Station, has outyielded all other grain sorghums in most sections of Kansas in experiments conducted for 5 to 10 years. The Club variety is now being distributed to farmers in Kansas.

In a regional cotton-variety study, which will continue for 3 years, the Bureau of Plant Industry is seeking information regarding production and quality problems at numerous locations in the main Cotton Belt, and at several in the irrigated valleys of the Southwest. More than 60 different characteristics under the general classifications of growing conditions, gin data, fiber properties, and spinning utility, will be studied. It appears, as a result of the experiments made during the first year, that characteristics such as staple length, lint percentage, weight of lint per 100 seeds, and fineness of fiber are inherited, and do not change much with changes in the environment. On the other hand, characteristics such as yield, the time required for emergence, the time required for the crop to reach the blooming stage, the time of opening, and maturity of fiber are modified to a considerable extent by seasonal and local conditions.

Blister Rust in Pacific States

As predicted from previous research, white-pine blister rust has appeared on sugar pine in Oregon and California. It took the disease about 15 years to spread to this host from Vancouver, British Columbia, where it was introduced from Europe. Although the disease is still some distance from the optimum range of the valuable sugar pine in California, there is no reason to expect that it will be any less serious on sugar pine than on western white pine. Tests in Oregon show that sugar pine is more susceptible to blister rust than either eastern or western white pine. Moreover, there are abundant susceptible *Ribes* in the sugar-pine forests, and marked damage has occurred on sugar pine in the relatively short time that the rust has been present. At one infection center sugar pines are dying from a multiplicity of branch cankers rather than from trunk girdling, which has been the characteristic method of killing in eastern and western white pines.

Powdery Mildew Resistant Cantaloup No. 45, a recently developed new strain, came fully up to its promise on the 10,000 acres grown in the Imperial Valley, Calif., in 1936. The vines were entirely free from mildew and the melons were not only of high quality, but showed outstanding adaptation to long-distance shipment. They reached markets in all parts of the country in a condition very satisfactory to both dealers and consumers. As a result most of the 1937 cantaloup acreage in the Imperial Valley and in Arizona, which sections produce most of the early cantaloups of the country, was planted to No. 45.

New Package for Peaches

Studies at Fort Valley, Ga., and Bonsack, Va., resulted in the development by the Bureau of Plant Industry of a ventilated package that permits the rapid cooling of all the peaches in a shipment when they are precooled in a loaded refrigerator car. The tight unventilated baskets previously used insulated the peaches, so that they could receive but little benefit from the precooling process. The drop in temperature was largely confined to the peaches in contact with the sides of the basket. Changes recommended for the half-bushel and bushel baskets give quicker cooling of the lading during precooling, and lower and more desirable temperatures while in transit. They should permit the shipment of more mature peaches of better eating quality. They call for the use of a basket with spaced staves, a crown cover, a slotted liner, and a ring pad which facilitates circulation of air through the package. The investigation also showed the desirability of establishing a standard for precooling operations so that the "precooler" can be operated until the pulp temperature is satisfactorily reduced, rather than simply for a specified length of time, as is the present practice.

Developments in Sugar Growing

Increased stability of production, with the gradual elimination of disease hazards through the use of resistant varieties, and a near approach to the maximum production of the past, are the outstanding present characteristics of sugarcane growing in the United States. Approximately 380,000 tons of sugar were produced from sugarcane in 1936, in sharp contrast with 47,000 tons produced in 1926. Improvement in quality and decreased cost of production, both attributable to the planting of new varieties, have contributed to this striking result. The improvement has been gradual and constant. There is room for further improvement in tonnage per acre and in pounds of sugar per ton of cane. A new sugarcane variety, C. P. 29/116, was released for commercial culture by the Bureau of Plant Industry, the Louisiana Agricultural Experiment Station, and the American Sugar Cane League in the fall of 1936. This variety, developed by the Bureau at the Sugar Plant Field Station, Canal Point, Fla., has been carefully tested for both sugar and sirup production at four field stations in the Gulf States during the past and 3 previous years, In production it is about the equivalent of one of the varieties most widely planted at present, and definitely more resistant to mosaic.

Success has attended the use of curly top-resistant varieties of sugar beets in western United States. Approximately 150,000 acres of the 280,000 acres in the curly top area were planted with these varieties in 1936. In the intermountain region, U. S. 33, U. S. 34, and A. S. C. 600 are used almost exclusively for production of the sugar-beet crop; in California, U. S. 33 is used very largely in spring plantings. With the greater curly top control which has resulted from the new varieties, the industry is returning to areas previously abandoned because of curly top, notably the Yakima Valley of Washington and the San Joaquin Valley of California.

INSECT PEST SITUATION

Extended drought and other weather conditions which have prevailed over large sections of the country during recent years have been favorable for the development of certain insect pests and native species have occurred in outbreak numbers over wide areas. The importance of these pests has attracted national attention and emphasized the need for concerted application of control measures to protect crops. To meet certain of these unusual conditions, such as the widespread outbreak of grasshoppers in 1934 and 1936, special funds and authorizations were provided to enable the Department to cooperate with States in combating these outbreaks. In other instances, special authorizations and appropriations have been provided for the eradication of infestations of new pests that have gained local foothold.

No definite principle had been outlined, however, in regard to Federal participation in efforts to combat incipient and emergency outbreaks of insect pests and plant diseases. In certain instances when funds and authorization were provided for cooperating with the States for the control of emergency outbreaks of insect pests, and especially for the grasshopper outbreak of 1936, they became available so late in the season that fully effective work was not practicable. Public Resolution No. 20 of the Seventy-fifth Congress, approved April 6, 1937, authorizes appropriations of $2,000,000 for the control of incipient and emergency outbreaks of insect pests and plant diseases. While the amount authorized is somewhat less than that required and provided to meet unusual situations which have occurred on one or two occasions, this legislation definitely establishes the policy that the Federal Government will cooperate with States to protect agriculture from emergency outbreaks of insect pests and plant diseases and from incipient infestations that may be located. The soundness of such a policy and the advantage of having such an insurance fund immediately available has already been demonstrated. It has permitted the Department to take prompt action against a potential insect pest of major importance recently discovered in limited parts of two States.

Influence of the Weather

Although drought and other unusual weather conditions of the past few years have been favorable to some of the 7,000 kinds of insects recognized as important agricultural pests, these factors have had a reverse effect on other important pests. The cotton boll weevil, for example, has been less abundant. For several years the annual losses from it have been well below the average of the preceding 12 years. The current season has, however, been more favorable to this pest. While the loss this season will be less than the annual average, there are many indications that the recent reduction in the abundance of the cotton boll weevil is only temporary. The extreme cold of the winter 1935–36 adversely affected two important pests of cereal crops, the hessian fly and the chinch bug. This and other factors, especially the weather in the spring of 1936 which was unfavorable for the chinch bug, so reduced these pests that impending outbreaks failed to develop and

noticeable damage occurred only in limited areas. The cold of that winter also almost eliminated the San Jose scale, where it was not protected by snow, throughout the East Central States and eliminated the harlequin bug in the area north of 30° latitude in which it had advanced and become an important pest of cabbage and other truck crops.

During the current season the armyworm occurred in outbreak numbers over practically all the territory east of the Rocky Mountains, and caused material crop losses in the States as far north as the Canadian border and extending into southern Canada. The unusual abundance of this pest in Southern States during the early part of the season prompted the Department to furnish bait materials to certain cooperating States to aid in controlling it. This made it possible to protect certain crops that would otherwise have been destroyed.

Grasshopper Outbreaks

Grasshoppers occurred in outbreak numbers and attracted more attention than other agricultural pests. An outbreak of grasshoppers in some 24 Western States was anticipated, and a budget estimate requesting funds to enable the Department to cooperate with the States in an effort to protect the cultivated crops was submitted on March 17. Congress appropriated $1,000,000, half the amount requested, and a cooperative control campaign, similar to that of 1934, was started. The Department supplied materials for the preparation of bait at designated localities, and the cooperating States made themselves responsible for receiving, mixing, and distributing the bait. In only a few localities were the weather and other conditions unfavorable to grasshoppers. With only a few exceptions, grasshoppers occurred in the localities and numbers indicated by the cooperative survey on which the estimate submitted by the Department was based.

Mormon crickets occurred in outbreak numbers in seven of the Western States and appeared in considerable numbers for the first time in North Dakota and South Dakota. These insects attack a wide variety of crops but are usually most destructive to small grains where they feed on the kernels and cause the heads to appear as if partially threshed. On March 17 funds from the emergency relief appropriation were allotted to the Department to enable it to cooperate with States where this widespread outbreak occurred. The Department supplied the labor used in applying the control measures; the cooperating States and local agencies contributed materials and the transportation of men and materials.

During the summer of 1937 an unusual outbreak of stableflies occurred in the North Central States. The adult resembles the housefly but is vicious and feeds on warm-blooded animals. The larvae or maggots breed in straw and other vegetable refuse. While the fly does not kill the animals, its presence is so annoying to them that it causes material loss in weight and a marked reduction in the milk flow of dairy cattle. This outbreak caused serious losses to farmers and stock raisers, and emphasized the importance of the proper disposal of the waste plant material that provides favorable breeding places for stableflies. A widespread outbreak of encephalomyelitis, or brain fever, of horses occurred in this same general area. It has recently been shown that this important disease is transmitted by certain mosquitoes. The outbreak this season indicates the need of further studies to determine whether or not other insects may also act as carriers.

Outbreaks of Screwworm

The screwworm, an insect that lives on the live tissue of warm-blooded animals and is one of the most important pests of livestock in southern United States, was discovered in a number of localities in the Southeastern States during the late summer of 1933. That season and the following spring it developed in outbreak numbers over much of this area. It was previously unknown from this section and farmers and others were unfamiliar with methods for its control. In 1934 special funds and authorization were provided to enable the Department to cooperate with the States in carrying on educational and demonstrational campaigns to acquaint livestock owners with methods of protecting their animals from this important pest. In 1935 this campaign was extended to include the Southwestern States, where the pest had been and continued to be unusally abundant although it had been known to occur in this region since it was settled. At the close of the summer of 1936 screwworm infestations had been very greatly reduced and the insect was less prevalent throughout the entire section than in previous years.

New Pest Discovered in Florida

During the late summer of 1936 two specimens of a weevil collected in Florida were forwarded to specialists of the Department in Washington for identification. These proved to be an insect not previously known to occur in the United States but described from specimens collected in parts of South America. The insect belongs to a group which includes many important plant pests, although nothing was available on its habits or to indicate that it was of economic importance in its native home. Only a few specimens of adult beetles were avilable for study last fall. Surveys made during the spring of 1936 disclosed the presence of the immature stages in many fields in two counties in Florida and two adjacent counties in Alabama. The grubs feed on the roots of a wide variety of plants. They had killed practically all the vegetation in certain fields. The damage that the grubs had done by feeding on the roots of such important crops as corn, peanuts, cotton, and alfalfa demonstrated that it is a pest of potential importance to a large part of the United States.

After preliminary study of the habits of the insect, the Department outlined a tentative program for its control, and began efforts to suppress it. The work was financed by allotting funds from a special appropriation for the control of incipient and emergency outbreaks of plant pests. This included surveys to determine where the insect had become established, the digging of trench barriers around infested fields, and cooperation with the States in enforcing quarantines to check its spread into new areas. Inspections in other sections disclosed a small infestation in the southern part of Mississippi. With this exception the insect is still restricted to an area about 35 miles long and 7 miles wide in four counties in Florida and Alabama.

The Pink Bollworm

The infestation of pink bollworm found in southern Georgia and northern Florida in 1932 has been eliminated, and the quarantine on account of this pest has been removed from the two States. Scattered and very light infestations of the pink bollworm still persist in some localities where wild

cotton has not yet been eliminated from the keys in the southern part of Florida. Definite progress is, however, being made toward the elimination of this noneconomic host and the accompanying infestation.

In 1936 an infestation of the pink bollworm was found in the lower Rio Grande Valley in both Texas and Mexico. This infestation though light involved a large area. In both countries quarantines are in effect and work is under way to eliminate the pest as far as practicable from both the Texas and Mexican parts of the infested area, which is practically contiguous with the main Cotton Belt of the United States. This difficult task will require intensive and concentrated cooperative effort over a considerable period.

Dutch Elm Disease

An intensive effort is being made by the Department and cooperating States to eradicate the Dutch elm disease which threatens the destruction of elms of the United States. This disease was introduced through the importation of burl elm logs imported for furniture veneer. It was first found in the United States in 1930. In 1933 it was rather generally prevalent in the vicinity of New York Harbor. Since then concerted effort to eradicate it, supported by regular and emergency funds, has been an important activity of the Department. The disease was introduced at several points and the infections in all the outlying areas have been suppressed.

The present center of infection includes a small area in a radius of 70 miles of New York, N. Y., in the States of New Jersey, New York, and Connecticut. Intensive scouting this year did not disclose any new outlying infections, though diseased trees were found at Wiley's Ford, W. Va., across the Potomac River from an outlying infestation discovered at Cumberland, Md., in 1936. The number of infected trees located this season in the generally infected area around New York Harbor was materially less than the number located the preceding season. This result of the eradication work is very encouraging. There is reason to believe the disease can be eradicated and the elms of the United States, valuable for shade and lumber, protected from the destruction that has occurred in various European localities such as Brussels, Versailles, and Cambridge.

New Virus Disease of Peach Reported

Peach mosaic, a new virus disease of peach and probably other closely related stone-fruit trees, was reported in Texas in 1931 and later discovered in local areas in Arizona, California, Colorado, New Mexico, and Utah. In the important peach-producing area of western Colorado it has infected thousands of trees. In 1935, with funds from emergency sources, an intensive campaign was begun to eradicate this disease and all known infected trees removed from the infected areas in Colorado and Utah.

Extensive inspection and eradication work have been carried on in other areas and scouting this season disclosed the presence of the disease in part of Oklahoma. The cooperative work against it is continuing with regular and emergency funds in many infected areas and all diseased trees are being removed and destroyed as fast as they are found.

During the last half century and up to recent years the principal pest hazard faced by the growers of small grains in the North Central States has been the occasional extensive and devastating outbreaks of black-stem

rust. During warm moist seasons these outbreaks prove particularly disastrous in the Northern States growing spring grains. Rust in this region came from two sources—barberry bushes that serve as the spring host for the fungus and spread it early in the season to nearby grainfields, and the spread of rust from the winter grains of Texas and Mexico where the summer stage of the disease survives throughout the year and where the barberry is not required for its development. Since 1918 the Department has been cooperating with 13 States in the elimination of all local sources of early spring rust spores.

The benefits from barberry eradication are pronounced. The numerous local epidemics of rust which occurred year after year before control work was undertaken have been eliminated, as well as the extensive rust development which resulted from the coalescing of local epidemics during years favorable to the spread of the disease. During the serious and extensive stem-rust outbreaks of 1935 and 1937, the strains of the fungus that caused the most injury were those which survived the winter in Texas and Mexico. The substantial absence of barberry bushes in most of the spring wheat-growing areas prevented infection of oats and rye produced there, and there was practically no loss to these crops. Spring grains planted early on well-prepared soil matured with much less injury than crops seeded later, and these early fields would probably not have escaped damage if numerous barberries had been present in the vicinity.

FEDERAL-STATE COOPERATION

Recent developments in agricultural and home economics research add to the importance of coordinating the activities of the Federal Government in these lines with those of the State agricultural experiment stations and other research agencies. Each year the research becomes wider and more complex and deals with technical, economic, and social problems that transcend State lines. Coordination of Federal research and State research in agriculture is one of the important functions of the Department's Office of Experiment Stations.

Federal and State research cannot function effectively in closed compartments. Federal and State research workers deal largely with the same major problems or with related aspects of the same problems. Federal research deals primarily with the broad regional and national aspects, and State research more particularly with the local aspects. This makes joint action essential. Accordingly, the Department is working out cooperative research with the States in new and extended lines.

It is cooperating with the State agencies especially in important new research authorized by the Bankhead-Jones Act of 1935. This measure provides funds and facilities for cooperative research, particularly in the more fundamental problems of improved production methods, new and improved uses of agricultural commodities and byproducts, and the conservation, development, and use of land and water resources in farming. Besides maintaining cooperative relationships with each of the States separately, the Department works with groups of States. In this way it brings under regional, coordinated attack the major problems in crop adjustment, farm taxation, land utilization, rural life, and community organization. In the last fiscal year the Office of Experiment Stations recorded nearly 1,200 new

or revised major cooperative research agreements between the Department and the State experiment stations, many of which involved the coordinated work of groups of States.

Permanent Regional Studies

Regional studies launched during the depression on an emergency basis have developed into research of a more permanent character, with long time agricultural adjustments in view. All the State experiment stations are cooperating, for example, in agricultural adjustment investigations that look toward the better adjustment of regional and local enterprises to national requirements. These studies embrace, in well-defined patterns, all the principal scientific procedures of agricultural technology and economics, and blend the diverse findings in specific recommendations for farm practices. For example, there is a cooperative study under way of input as related to output in milk production. This is a typical cooperative research project in a regional and national problem of broad economic importance. It pools the work of specialists in the Department's Bureaus of Agricultural Economics and Dairy Industry, and in 10 of the State experiment stations and other State agencies.

The Bankhead-Jones Act of 1935 provides for the establishment and operation of research laboratories in major agricultural regions. Four major agricultural regions have been designated to carry out this provision. They are: (1) The North Central States region, which includes North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Michigan, Indiana, and Ohio; (2) the Northeastern States region, which includes the New England States, Pennsylvania, New York, New Jersey, Delaware, Maryland, and West Virginia; (3) the Southern States region, which includes Texas, Oklahoma, Arkansas, Louisiana, Kentucky, Tennessee, Mississippi, Alabama, Virginia, North Carolina, South Carolina, Georgia, and Florida; and (4) the far Western States region, which includes Washington, Oregon, California, Nevada, Idaho, Montana, Wyoming, Utah, Colorado, Arizona, and New Mexico. In each of these regions the State experiment station directors act as an advisory group in considering and recommending to the Department proposals for the establishment of regional laboratories.

Regional Laboratories Established

Six regional laboratories have been established. Three were established in 1936, and were mentioned in this report last year. These three deal respectively with vegetable breeding, soybean research, and grass breeding and pasture improvement. The remaining three were established in 1937: One at Ames, Iowa, for the North Central States region, will investigate swine breeding; another at Dubois, Idaho, for the far Western States region, will investigate sheep breeding; and the third at Auburn, Ala., for the Southern States region, will study the contagious, infectious, and parasitic diseases of domestic animals and poultry. The three new laboratories are under the supervision of the Bureau of Animal Industry. Thirteen States cooperate in the work at Ames, Iowa; 12 in the work at Dubois, Idaho; and 13 in the work at Auburn, Ala. These laboratories are serving as centers for coordinated research in important special lines of national as well as of regional importance. By virtue of their organization and

cooperative relationships with the States, they provide favorable conditions for the work.

The grass-breeding and pasture-improvement regional laboratory project is typical and has for its purpose research into laws and principles underlying improvement and better management and use of pastures in the northeastern region of the United States. In this laboratory project the Department's Bureau of Plant Industry is cooperating with 12 northeastern State experiment stations in coordinated researches in the agronomy, physiology, cytology, morphology, pathology, and genetics of pasture grasses to obtain basic facts and materials for pasture plant improvement and utilization throughout the region.

Federal and State agencies completed during the fiscal year a cooperative survey of plant and animal improvement. The findings provided material for the Yearbook of Agriculture for 1937, which volume continued a survey of superior germ plasm begun in the 1936 Yearbook. Together the two volumes furnish the most complete information available on the genetics and breeding of plants and animals of economic importance, and will constitute a guide for new cooperative studies in the development of plants and animals of superior merit. Another equally comprehensive cooperative survey has been started in soil science and related problems. The first results will be published in the Yearbook for 1938. Among other things this survey will include special studies in each State to determine the area that can be cultivated without serious erosion injury under present farming practices, and the area that could be cultivated without serious erosion injury under the best-known farming practices.

Cotton and Tobacco Investigations

Cooperative research during the last fiscal year achieved promising results with regard to the diseases of tobacco and cotton, and with regard to spray injury. Twelve State stations cooperated with this Department in a special investigation of cotton plant diseases. In a stabilized Federal-State program, the soil survey continued its work in 29 States, and completed an inventory of soil resources in 7 States. Twenty States cooperated with the Department in cereal crop investigations; 15 States cooperated with it in studies of cotton-harvesting machinery and of machinery for applying fertilizers to various crops.

Other cooperative studies dealt with farm incomes, with cereal and forage-crop investigations, with problems connected with the use of concentrated fertilizers, and with problems in home economics. In July last, several States and this Department organized the Tobacco Insect Council, and launched several cooperative research projects. Several of the Southern States experiment stations also cooperated with the Department in a study of jack-stock and mule production.

In the Northeastern States cooperative research in home economics is under way under the sponsorship of the Association of Northeastern Experiment Station Directors. One study deals with the performance of women's and children's silk, rayon, and cotton garment fabrics. Another study concerns vitamin C in human nutrition. Five Northwestern States are cooperating similarly in vitamin studies. Still another important field of cooperative investigation in home economics deals with household equipment. In this research a number of States are cooperating with the Depart-

ment of Agriculture and other Federal agencies, including the Tennessee Valley Authority, the Works Progress Administration, and the Rural Electrification Administration.

AGRICULTURAL CHEMISTRY

Shifts in production from one soil type to another, discoveries in agronomy, changes in the national diet, developments in medicine, and the industrial utilization of farm products and byproducts confront the farmer with new problems constantly. Among other things, these problems involve diverse applications of chemistry. Naturally, the chemistry of the soil is basic. Programs for the maintenance of well-adjusted agricultural production, for the proper utilization of different soils, and for the elimination of surpluses and wastes, must recognize local peculiarities of soils, and soil management. Such programs will depend for their success in the long run on the efficiency with which they combine the findings of chemistry, agronomy, and economics.

There is no single formula by which the farmer can make the necessary adjustments; each farm will require a particular combination of various elements. On the other hand, the individual farmer cannot work out all his problems alone. Many of them will oblige him to cooperate with other farmers in local and regional adjustments. The first essential in dealing with all these matters is precise information regarding the soil and its products and potentialities. Farmers also need to keep abreast of industrial changes and requirements. For example, the demand for plastics, new tanning materials, and alcohols affects agriculture significantly. These problems concerning the capabilities for use of the soils of the Nation and of the products which they support are the special concern of the Bureau of Chemistry and Soils.

The Bureau is continuing its detailed survey of the Nation's soils and classifying them by characteristics. The Department published its first soil survey in 1899. Since then it has mapped more than half the agricultural lands of the country as well as those of Puerto Rico and of portions of the other Territories. It has cooperated in the surveys with the agricultural experiment stations and with other State and Territorial agencies. The soil surveys afford a basis for the classification of other agricultural data. They indicate soil properties and soil deficiencies, and give direction to other investigations, such as the study of fertilizers. The results from controlled experiments on various types of soil help individual farmers in planning their operations.

Application of Soil Studies

Since, however, experimental results in one place do not necessarily apply to other places, the Department assists farmers to determine the particular combination of soil findings and other pertinent data that will suit them best. As conceived by the modern soil scientist, the soil type represents a summation of all the forces and factors that constitute the environment of a plant. Properly classified knowledge of soil types has immensely important practical applications, not only in farming but in general land-use planning, rural zoning, public-land acquisition, reclamation, erosion control, and flood control. Some counties use the soil-survey maps in making

tax assessments. Findings of the soil surveys directed attention more than 30 years ago to the dangers of accelerated erosion.

Greater attention should be given to the so-called trace elements in soils and plants—in other words, to the less common chemical elements which exist in the soils and in plants in minute quantities. Their presence or absence may have a marked effect. Some elements that are essential in small quantities, and others that are not essential, may be quite poisonous to plants if present in the soil in quantity. In some instances plants may have an excess or a deficiency of elements essential to animal nutrition, without any indication of the fact in the appearance of the plants. For example, selenium, when present in sufficient quantity in the soil, will be taken up by plants to a degree that will be harmful to the animals that consume the plants. Detrimental compounds may exist in the soil naturally, or may be brought in by irrigation water or in other ways. Analysis of certain nonfertile soils shows that they sometimes contain abnormally large quantities of arsenic, barium, selenium, boron, chromium, nickel, and magnesium. This may be the cause, or one of the causes, of their low fertility.

Deficiencies of Some Soil Types

Many soil types may be deficient in one or more of the necessary trace elements, especially after the land has been cropped for a long time. Ordinary fertilizers may not contain these elements in a quantity sufficient to correct the deficiency. It is, therefore, important to identify the deficiencies, and to apply the proper corrective fertilizers. Certain deficiencies in the soil have a pronounced effect on the appearance of the plant. These tend to be easily recognized. It is only recently that soil scientists have appreciated the importance of chemical deficiencies in the soil that do not show up significantly in the appearance of the plant. Such deficiencies may be of great importance to the value of plant products as food. Trace elements in the soil, even in minute quantities, may affect animal and human nutrition. Absence from the diet of certain trace elements may cause vital processes in nutrition and growth to stop, and may produce definite symptoms of disease.

It is well known that deficiencies of copper and iron cause anemia. Iron is necessary to regenerate the hemoglobin in the blood, and copper to act as a catalytic agent in making the iron utilizable by the hemoglobin. Manganese plays an important role in reproduction. Lack of iodine in the diet causes goiter. Lack of cobalt has been shown to cause certain deficiency diseases among sheep and cattle in New Zealand and Australia. Boron and aluminum have stimulating and prophylactic effects. Zinc appears to be essential in animal nutrition, though its function has not yet been determined. Some root crops take up arsenic from the soil. Some forage plants take up sufficient selenium to make them poisonous to sheep and cattle.

Selenium in Soils

Much attention has been given lately to the presence of selenium in soils. This appears to be confined largely to soils derived from particular geological formations, such as the Pierre and Niobrara formations. The Bureau of Chemistry and Soils has discovered a large area of seleniferous soils developed from these shales in the Great Plains States. Within this area the

soil at some places retains enough selenium to produce poisonous vegetation. Practically all the toxic seleniferous soils, however, are in regions of low rainfall where the land is submarginal for crop farming, and should be used chiefly for grazing. Irrigation with good water reduces or eliminates the toxic effects of the selenium. Whether or not living in regions of seleniferous soils injures the health of human beings has not been determined. It seems probable that the diet, even in highly seleniferous areas, is varied enough in kind and source to remain below the toxic limit. On the other hand, some soils are lacking or deficient in beneficial trace elements. They may be supplied, though possibly in an insufficient quantity, through the application to the soil of stable manure, cottonseed meal, and commercial fertilizers. Sometimes fertilizer manufacturers intentionally include the secondary or trace elements, particularly magnesium, with the nitrogen, phosphorus, and potassium contained in the ordinary fertilizer mixtures. They do so where the analysis of particular soil areas has shown the necessity.

Analysis of Fertilizers

Investigations in the Bureau have shown that in the development of new phosphatic and potassic fertilizers, it is essential to identify the compounds present in various fertilizing mixtures in order to establish the best conditions for their preparation. This may be done by chemical analysis. Sometimes examinations with a microscope and with X-ray diffraction instruments is necessary. This method has established the composition of phosphate rock, and shown the changes it undergoes in the preparation of superphosphate, and of the new calcined phosphates. The atomic arrangements of other compounds of interest to agriculture may be determined by X-ray diffraction. Such knowledge helps the soil scientist to explain the peculiar properties of the fine-grained material of soils. This material largely determines the character of soil types.

Spectroscopic and photochemical studies of mixtures of nitrogen oxides and other substances such as oxygen and ozone have resulted in important contributions to our knowledge of the composition and constitution of these systems. Other investigations deal with the nitrogen-fixing soil microorganisms, which supply growing crops with much of the nitrogen they require. These organisms include the *Azotobacter* and other free-living bacteria, the legume root nodule bacteria, and certain blue-green algae. Laboratory experiments with *Azotobacter* showed that increases in nitrogen fixation amounting from 100 to 500 percent may result from additions of molybdenum, which acts as a catalyst in the fixation process. Inquiries are going forward into the conditions under which bacterial cells evolve ammonia. Research of this type, which probes into some of nature's deepest secrets, adds something annually to our fund of usable knowledge.

Utilization of Lignin Foreseen

Current experimental work gives promise of developing a wide and large-scale utilization of lignin. Lignin is one of the three principal constituents of wood and crop byproducts, and acts as a cementing material between the cellulose fibers. Pulp and cellulose manufacture removes and wastes it more or less completely. Experiments have shown that lignin, lignin compounds, and lignin complexes may be useful in treating industrial water supplies, to remove undesirable constituents such as iron, manganese,

and fluorine. In effectiveness these compounds compare favorably with costly commercial products developed for treating industrial water supplies. Complex lignin compounds show promise in the removal of lime and magnesia from water supplies and should therefore have commercial utility in the treatment of boiler feed waters. Experimental work will shortly be started in the Agricultural Byproducts Laboratory at Ames, Iowa, in the production of power alcohol or other liquid fuel from farm crops and byproducts. Other experimental work there deals with the utilization of agricultural materials in the production of plastics, and with the chemical conversion of oils, fats, and waxes, into industrially usable compounds. In the last year the Bureau developed a greatly improved method for obtaining high-grade commercial starch from sweetpotatoes.

ANIMAL HUSBANDRY INVESTIGATIONS

Research in veterinary science and animal husbandry furnished some important results during the fiscal year. Investigators gave particular attention to the vaccination of calves, as a means of combating Bang's disease. This malady, through its tendency to cause abortion, strikes at the foundation of cattle breeding and herd improvement. Vaccination during calfhood seems to be the most promising method. In five experiments the investigators used 63 vaccinated and 52 control animals. In the vaccination process they employed a *Brucella abortus* strain of low virulence. Both the vaccinated and the control animals were exposed to *Br. abortus* during pregnancy. About 89 percent of the vaccinated animals resisted the disease entirely, as compared with 27 percent of the control animals. Calfhood vaccination is now being tried in several hundred infected herds in different parts of the country to determine its efficacy under actual farm and herd conditions. Vaccination against Bang's disease, however, is still in the experimental stage and cattle owners should bear in mind that the vaccine contains living Bang's disease germs. It is a preventive only, not a curative agent, and cannot be expected to benefit cattle already infected.

In cooperating with State agencies this Department is continuing the testing of cattle for Bang's disease, and the slaughter of reactors. Agglutination tests were applied during the year to more than 8,000,000 cattle. About 5 percent proved to be reactors. Nine percent of the reactors were purebred registered cattle. The Government paid indemnities for condemned animals—the maximum being $50 for a purebred registered animal and $25 for a grade. The payments during the year approximated $10,532,000. Surveys showed that herd owners have it largely within their own power to keep tested herds free from a recurrence of Bang's disease. The chief cause of its reappearance in tested herds is the addition of untested cattle. Cattle for addition to herds that have been tested, and pronounced free of Bang's disease, should be selected from herds that are entirely negative to the agglutination test. It is advisable, also, to keep the new animals apart from the herd until a second negative test is obtained.

Eradication of Bovine Tuberculosis

In the Federal-State campaign against bovine tuberculosis, the cooperating eradication forces applied approximately 13,750,000 tuberculin tests to cattle during the year, disclosing 0.7 percent of reactors. Since last

year's report, five States—Rhode Island, Vermont, Pennsylvania, Maryland, and New Jersey—have been added to the modified accredited area—that is, to the area with less than 0.5 percent of tuberculosis infection among its cattle, as determined by official testing. Forty-five States now belong to the modified accredited area, and more than 98 percent of all the counties in the United States have been admitted. New York, South Dakota, and California, the remaining States, are pressing the eradication work.

Tuberculosis in cattle has been reduced in the last two decades, for the United States as a whole, from more than 4 percent to about 0.4. This eradication program, with close veterinary control over the interstate shipment of cattle, means the virtual elimination of the disease as an economic handicap to producers. Meat-inspection records for the fiscal year 1937 bore witness to the downtrend. Condemnation of cattle carcasses because of bovine tuberculosis were one-third fewer than in 1936 and condemnation of parts of carcasses 50 percent fewer. These figures are based on thorough veterinary post-mortem examinations of millions of animals, and furnish conclusive evidence that bovine tuberculosis is a vanishing disease in the United States. Physicians have credited the eradication program with much of the recent decrease in human tuberculosis, particularly in the bone and joint types of the disease that occur principally in children.

Commercial production of anti-hog-cholera serum and hog-cholera virus, and marketing conditions for these products, were brought during the year under a marketing agreement, which promises to bring about a further advance in the control of hog cholera. Conferences between leaders of the serum-virus industry and officials of this Department culminated in a marketing agreement and order executed by the Secretary on December 2, 1936, and published as Bureau of Animal Industry Order 361. These documents have legal status by virtue of an act of the Seventy-fourth Congress (48 Stat. 781–782), which provides for Federal supervision over the distribution of anti-hog-cholera serum and hog-cholera virus when all commercial interests engaged in the interstate handling of at least 75 percent of these products sign the marketing agreement.

Serum-Virus Control Agency

The agreement and the order bring into existence a control agency consisting of 12 members of the serum-virus industry. Each handler must file with the Secretary and with the control agency a list of his selling prices to each class of buyers and must indicate the terms of sale and the discounts. These lists must become available immediately to the press and to the public. The Secretary has authority to disapprove them, and to terminate the agreement should need arise. In the past the production and distribution of anti-hog-cholera serum and hog-cholera virus have been handicapped by lack of uniformity in trade practices, and by fluctuations in the seasonal and yearly demand. It is expected that the new plan of operation will improve the situation greatly. As is well known, this Department discovered and developed the preventive serum treatment. It also administers the Federal Virus-Serum-Toxin Act of 1913 to insure the purity and potency of biological products.

Experiments in the control of animal parasites indicated that deep plowing of pastures will help to control horse strongyles. In efforts to control this

parasite horse owners have long sought a practical simple means of eliminating the infective larvae from pastures. It has been demonstrated that deep burial of the larvae is effective, especially in clay and sandy clay soils. When buried to a depth of about 8 inches in soil of these types, comparatively few of the larvae reach the surface.

Records of four meat-packing establishments that operate under Federal inspection in southern Georgia, Alabama, and northern Florida, indicated the importance of hog-lot sanitation and similar methods of parasite control. In 95,000 hogs raised by ordinary methods, and slaughtered at these four packing plants, less than 6 percent of the livers and less than 2 percent of the kidneys were sufficiently free from infestation by swine kidney worms to be saved for food. In one establishment, 239 carcasses had to be condemned in a single month for extensive kidney worm infestation. Swine growers in the vicinity adopted recommended swine-sanitation procedures, with remarkable results. In 821 hogs from 85 farms on which hog-lot sanitation projects had been maintained, 87 percent of the livers passed Federal inspection, and 93 percent of the kidneys and the kidney fat.

Trichinae in Pork

Recent experiments confirmed previous results showing that a temperature of 137° F. is fatal to trichinae in pork, and makes pork heated to or above that point safe for use as human food. Many people in the United States, however, eat uncooked pork products. It is therefore desirable that the trichina parasite in hogs be reduced and if possible eliminated. One way is not to feed hogs on raw garbage. Field investigations and laboratory tests demonstrated that feeding swine on raw garbage perpetuates the trichina parasite. Investigators obtained several thousand samples of pork from various localities. The percentage that contained trichinae was greatest in the hogs that received raw garbage as the principal part of their feed. In fact the frequency of trichinae in hogs fed on raw garbage was about 11 times as great as in hogs that received a non-garbage ration.

Research in animal breeding emphasizes the significance of certain body measurements. Record-of-performance data indicated that height at withers and length of body in beef steers are closely associated with efficiency and rate of gain and carcass quality. Body measurements of sheep at various ages from 2 to 12 months showed that even at the early ages such measurements may indicate what the form of the mature animals will be. Weight at birth is a fair index of the probable growth during the first year. Important advances were made in the artificial insemination of both sheep and poultry. With sheep the results showed the possibility of using meritorious rams for the improvement of flocks long distances away. In the case of poultry, improved technique makes possible the fertilization of as many as 75 hens per male.

Forty-one States participated in the national poultry improvement plan sponsored by the Department. This has now completed the second year of operation. It promotes systematic methods of improving the quality of hatching eggs and breeding stock, and of reducing the prevalence of pullorum disease, long a serious handicap to the poultry industry. It embraces about 13 percent of the hatcheries and nearly 17 percent of the estimated

hatching capacity of all the hatcheries in the country. As part of the program, more than 300 poultry breeders trap-nested about 112,000 birds in record-of-performance provisions of the plan. A distinctive emblem designed and furnished by the Department serves to identify the products of hatcheries and breeders that participate. The plan includes a tentative turkey-improvement program.

Rulings Affecting Packers and Stockyards

Under the Packers and Stockyards Act the Department has sought to reduce livestock-marketing costs, to the extent that this can be done with fairness to all concerned. In July 1937 a Federal court order for the second time sustained a 12-percent reduction in rates charged by livestock commission firms operating in the Kansas City yards. By the end of the fiscal year approximately $500,000 had been impounded for subsequent return to farmers and stockmen who had traded in the yards since July 1933. This sum represents the difference between the old rates charged and the lower rates ordered by the Secretary of Agriculture. The money was impounded by the court after commercial firms obtained a restraining order several years ago. The Department's first inquiry into Kansas City commission rates was in 1930. Certain aspects of the case still await determination in the courts.

The Department ordered a downward revision, effective March 19, 1937, of yardage, feed, and other charges at the Denver Union Stockyards. This will mean an annual saving to livestock shippers of about $50,000, the difference between the revenue from the old rates and the revenue from the new charges. The order followed hearings that brought out voluminous testimony and data covering rates and charges, the valuation of stockyard property, and details of stockyard operation. For example, the Department decided that loading and unloading livestock from railroad cars are transportation services which cannot properly be charged as stockyard expenses. The inquiry showed that certain deficits incurred in connection with local livestock exhibitions have been absorbed by the stockyard company. Though recognizing the beneficial effect of such exhibitions, the Department held that the deficit should not properly be charged to stockyard expense. The new rates should suffice for the efficient operation of the yards, and should cover all expenses, repairs, and depreciation. They also allow approximately 6½ percent return on a fair valuation of the property actually used in rendering stockyard services. This case has been appealed to a Federal statutory court of three judges. Excessive charges will be reimbursed to shippers if the Secretary's order is upheld.

Live-Poultry Market Supervision Upheld

The United States District Court of the Eastern District of Pennsylvania, on October 9, 1936, upheld the constitutionality of an amendment added by Congress to the Packers and Stockyards Act to provide for the Federal supervision of live-poultry marketing. This question came before the court in *Handy Bros.* v. *The Secretary of Agriculture*. It was the first court case that involved the amendment, the purpose of which is to protect shippers and producers of live poultry against unfair practices by commission men and dealers, and against having to pay unreasonable rates for services. Several live-poultry markets, including those of New York, Boston, and Chicago,

have been brought under Federal inspection. Many commission men and dealers who handle live poultry now operate under licenses issued by the Secretary in conformity with the legislation. In March 1937 the Department set new rates for handling live poultry in the metropolitan area of New York. This action followed a hearing which investigated the reasonableness of the rates and charges at certain live-poultry markets in that area. For unloading poultry the new order authorized a maximum rate of $41 a car, or $11 less than the usual charge in the New York market. The rate for "lightening" a car, the service which consists in unloading only a designated part, is $20.50—half the full unloading charge. On legal holidays and Sundays the order authorizes one and one-half car rates. This decision was the outcome of an inquiry that had been in progress for a year. It showed that the usual charges for unloading live poultry were unreasonable, and that the establishment of reasonable rates would reduce the costs to shippers by approximately 30 percent. It was recognized, however, that such a reduction would probably cause hardship to the unloaders, and the order established compromise rates so as to give the unloaders time to adjust themselves to the new conditions.

AGRICULTURAL ENGINEERING

Recent developments in agricultural engineering are of definite advantage to the family size farm. Lighter, faster, and more adaptable power units, and other new machines notably the small combine harvester, give to relatively small farms advantages previously available only to large farms. There is progress toward better methods of reducing the waste of water, of fertilizer, and of animal power. Machinery helps also in controlling plant diseases, insect pests, and soil losses. Farms are becoming more efficient through the improvement and extension of drainage systems. Better design of buildings, and the provision of adequate buildings, make crop rotations more flexible and efficient, and facilitate the growing of more grass and other forage crops.

Many farmhouses are convenient and have electric power and other modern equipment; but the percentage thus equipped is small, and little building of new farmhouses or remodeling of old buildings is in progress. As in the past, farmers tend to invest their surplus capital in means of production rather than in home improvements. Repair and replacement of farm homes generally does not make up for their depreciation. This is poor economy. Farm homes and farm buildings in general offer many opportunities for better engineering. In a recent study of more than 100 better-than-average farms in 7 States, investigations indicated possible engineering changes on every farm that would increase its operating efficiency, or improve the family standard of living. Many good farms are so poorly equipped with buildings that the livestock cannot be handled properly. This affects the production in quantity, quality, and variety, and decreases the labor efficiency. Many farms have small irregular fields that waste time, and limit the use of machines. Some farms could use more machinery; others already have too much. Many could carry more livestock and employ more labor were they better drained or cleared of stumps. Buildings could be better arranged, and farmsteads better planned. With good buildings of sufficient capacity, the way is open for more grass and other

forage for which a livestock outlet is necessary; they make possible the use of more labor; and they make soil conservation and control of surplus crops easier. Most farms not well equipped with buildings are on a cash-crop basis.

Evolution of the Tractor

Tractors in the past were expensive giants that required much space in which to operate. Now there are general-purpose tractors, on pneumatic tires, light and fast, and easily handled in small fields or taken on the road to haul produce at 15 miles or more an hour. The small, combine grain harvester, pulled by the same small tractor cuts a 5- or 6-foot swath at 5 miles an hour. A disk jointer for plows, designed by the Bureau of Agricultural Engineering, requires less power than the older devices and helps control pests, such as the corn borer. A variable-depth cotton planter, also designed by the Bureau, practically eliminates the need for replanting. In an area near Montgomery, Ala., where ordinary planters were used this year, replanting was necessary on more than 50 percent of the farms. Where the variable-depth planter was used, no replanting was necessary. The variable-depth cotton planter reduces germination hazards. The sugar-beet planter facilitates planting and simplifies later operations. Fertilizer distributors place the plant food where it will do the most good, and nowhere else. Progress is being made in conserving water for irrigation, in the accurate measurement of water, and in the development of "water spreading" as an economical means of storing surplus water underground. In humid regions, economical ways are being found to provide irrigation in short, dry periods.

There is a decided trend toward increased expenditures for farm drainage, not primarily to bring additional lands into cultivation but to maintain existing drains and to improve land already in farms. Drains require constant maintenance. The Civilian Conservation Corps drainage camps, working on public ditches under the direction of the Bureau of Agricultural Engineering, have restored many ditches to high efficiency and demonstrated the benefits of improved drainage. Good drainage means aeration of the soil, warmer soil, better tilth, more favorable bacterial growth in the soil, deeper root penetration, and greater drought resistance. Agricultural engineers in the Department are developing better ways to maintain drainage ditches and more effective equipment for the purpose. They are ascertaining the run-off that should be provided in drainage systems, developing more efficient designs for drainage structures, and studying the properties of various materials used in making drain tile.

Forecasting Water Supplies

Forecasting of irrigation water supplies, a development made possible through correlated snow-survey reports started 2 years ago, is giving western irrigation farmers an accurate basis for planning crop production. Such surveys had been used for several years in Utah, California, and Nevada. Under a coordinated Federal-State program these States have extended their work. Oregon, Washington, Montana, Colorado, New Mexico, and Arizona have adopted and expanded it. These cooperating States have three-fourths of the 20,000,000 acres of irrigated land in the West. Snow-water forecasts are telegraph news for the press. They help in flood fore-

casts; in controlling reservoir storage; in forecasting water supplies for cities and hydroelectric enterprises; and in crop forecasting.

Studies of the effects of timing the applications of irrigation water to different crops show that better understanding of periodic water needs will lead to improved methods of water delivery. Other studies have brought valuable facts on the total water consumption of various crops. Such information on water consumption and on the right time to apply water is of importance not only in the successful growing of individual crops but in deciding questions concerning the conservation and reallocation of irrigation water. The Bureau's experience in irrigation problems has served recently in furthering plans for safeguarding and developing water resources. An example is a survey just finished for the National Resources Committee, which included an estimate of the consumptive use of water by crops and native vegetation in the 2,000,000-acre Rio Grande Basin. Greater accuracy is being attained in forecasting the irrigation water supply by means of snow surveys. New facts are accumulating on the use that can be made of saline waters and on the control of ground-water tables. Results indicate that irrigation may play a part in farming where it now has small place, such as in the production of fodder crops in grazing areas.

Farm Structures

In planning the construction of farm buildings, and particularly of farmhouses, it is desirable to correlate the knowledge of architects, home economists, and agricultural engineers. Cooperative services looking in this direction have been developed by groups of States and this Department. Studies by the Bureau of Agricultural Engineering in Northern and also in Southern States have been started to show how the convenience and comfort of the farm home may be increased. For example, in a Northern State (Wisconsin) the studies have shown great temperature differences in different parts of the same farmhouses. On very cold days the difference between the floor and the ceiling may be as much as 30° F. There may be almost as much difference between one side of a room and another. Such conditions restrict the daytime use of the house in the winter to one or two rooms, and even to parts of these rooms. This is a typical illustration of the opportunities for improvement that exact studies may disclose.

Agricultural engineers, dairymen, and veterinarians have cooperated to find out how conditions in the dairy barn affect the health and the milk yield of cows. They have found that moderately cool temperatures of 45° to 55° F. are most satisfactory in northern sections, and that drafts are decidedly injurious. It is not necessary to maintain barn temperatures of 60° or more in cold climates; but keeping temperatures uniform and eliminating drafts will reduce disease, especially pneumonia, and increase the milk yield.

Cotton-Ginning Practices

The Department's Cotton Ginning and Fiber Laboratory at Stoneville, Miss., has developed information which is exerting an important influence on cotton-ginning practices. Seven States are now cooperating in extension work with agriculutral engineers to improve the quality of cotton through better harvesting and ginning. Studies have shown that improved arrangements of piping and fans in gins materially reduces the power

requirement and saves expense. The cotton drier recently developed by the Bureau is being more widely used as larger numbers of farmers and ginners learn of the improvements in grade and price that it brings about.

About 2,500,000 American farmers use 7,000,000 tons of fertilizer a year at a cost of $180,000,000. Recent improvements in fertilizer-placement machinery give a more uniform distribution of the plant food, and also a more effective placement of it. Research stimulated by the development of more soluble fertilizers has covered many crops and shown that in most cases the best results are obtained by placing fertilizer 2 to 3 inches to the side of row crops and 3 or 4 inches deep. The common practice is to plant it in the row or to broadcast it. Surprising gains have resulted from the new method. Snap beans have yielded an additional 1,000 pounds to the acre, entirely as a result of proper placement. Potato yields have been stepped up 30 to 40 bushels. Cotton has turned out an additional 350 pounds of seed cotton per acre.

Agricultural engineers in the Department have developed a basin-forming lister in combination with a planter. The machine plants corn in a furrow where little basins are formed. This method holds water in the soil and checks erosion by both water and wind. Use of the machine is increasing rapidly and several manufacturers make it.

Bureau engineers also have devised a self-alining disk jointer and a trash guide for plows. Used together they cover cornstalks and weeds almost completely, and greatly aid in controlling the European corn borer. The disk jointer reduces plow draft by 10 to 15 percent.

FORESTRY

National forests administered by the Department's Forest Service include 174,198,902 acres net in 38 States, Alaska, and Puerto Rico, and embrace parts of every forest region and every major mountain system. Federal care maintains and manages forest-land capital so that it provides steady jobs, continuity in forest industries, and a two-way movement of commodities, one of outbound freight and another of foodstuffs and merchandise moving in. For example, half the people in Flagstaff, Ariz., depend directly or indirectly on forest products from the Coconino National Forest. Ponderosa pine on the Harney Forest in South Dakota contributes 20,000 man-days of work each year to a nearby but scattered population. In certain Montana counties thousands of people depend in large part on the planned and regulated use, by domestic livestock, of national-forest forage. In many other localities a large percentage of the population depends directly or indirectly on forest-land resources.

However, private ownership now holds four-fifths of the commercial forest land we have left; almost three-fifths of the remaining commercial saw timber; and at least nine-tenths of all potential forest growing capacity. Approximately 98 percent of all our forest products still come from these private lands. In general, wasteful exploitation continues there. From 1925 to 1929 normal drain on all our timber was about twice as great as the normal growth; in the important saw-timber sizes it was around five times as great. Private ownership holds the key to the manner in which by far the largest part of our forest land is handled.

Much of the South is still in forest. It is a fine timber and naval stores-producing region. Forest lands are among the South's important physical bases of prosperity, and both agriculture and industry have an interest in their management. Over most of this area one farm out of every two in 1935 depended partly on forest products cut from farm woodlands, and valued at close to $44,000,000. In the same year forest industry employed a considerable percentage of the South's industrial labor; and supported about 1 million people. In addition, farmers marketed cultivated crops to forest industry workers and their families.

The per-capita consumption of paper in the United States is rising. In 1935 it was 198 pounds. It may exceed 220 pounds in 1936. Pulp and paper interests in the South are expanding their production, and this expansion offers prospects of increased employment. But it may double existing pulp and paper demands on southern forests. This creates problem. If wasteful cutting continues, without provision for regrowth, the South's forest industries may disappear as did those of the Lake States region. If sufficient growing stock is left to restore the forests, the expansion now planned will do no harm.

Sustained Yield Needed on Private Lands

Permanent prosperity requires that forest lands privately owned shall produce successive forest crops. Southern pulp interests have recently endorsed woods-practice rules. Though not adequate to assure sustained-yield operations, the rules may be revised after a trial. This is a step in the right direction. But pulp buyers have bought from many farmers certain timber rights, covering forest land that bears from 10 to 20 cords per acre, with some stands growing at the rate of a cord per acre per year. With a purchase price reported to average only $3 an acre in some instances; with some contracts allowing a long term of years in which to operate; with features that call for cutting all the timber; and with no basis provided for future crops, the outlook is for continued forest exploitation. Such programs suggest that public cooperation with private owners, like that which the Forest Service has been authorized by Congress to maintain regularly, may not in itself be adequate to meet our forest situation, and may need to be supplemented with regulatory legislation.

Such cooperation has been decidedly helpful in the past. Federal research has eliminated or lessened various handicaps and laid a foundation for the productive use of forest and range lands in private, State, and Federal ownership. For fire protection alone, the Federal Government has contributed more than $20,000,000 cash, plus work by the Civilian Conservation Corps valued at some $60,000,000 more. Through a division of State and private forestry, the Forest Service helps owners to put forest lands in better shape, and thus to improve social and economic conditions in forest areas. The Forest Service cooperates with State forest organizations and with the extension services. One way is in making sustained-yield surveys, one of which covers some 140,000 acres in Vermont and New Hampshire. Benefit payments are available in many States through the Agricultural Adjustment Administration for tree planting and satisfactory timber-stand improvement work applied to farm woodlands, and in the South for improved naval stores practices.

Cooperation With Forest Owners

Federal cooperation with private owners of forest land in one recent year led 13,779 farmers to make selective cuttings in their timber stands, while 7,197 made improvement thinnings, 11,631 planted small trees for timber production, and 20,973 planted trees to establish windbreaks and control soil erosion. Up to June 30, 1937, 2,602 miles of shelterbelts and 6,474 acres of farmstead plantings had been made in Prairie-Plains States, as a cooperative emergency project. Farm forestry throughout the country will be expanded further when funds are available under the new Norris-Doxey Act. Some privately-owned forest lands are receiving better fire protection, and some owners are leaving cut-over tracts in better shape. On most farm woodlands and privately-owned forest lands, however, improved practices are still the exception. Timber matures so slowly, however, that there is need for more public acquisition of forest land, and for public control over the use of private forest land. This is indispensable to protect the national interest in forests and good land use generally; more so today than formerly because past practices have created a serious problem for forest devastation accompanied by soil erosion and increased flood hazards.

Within the 127,000,000 acres of the Ohio River drainage basin, an area that includes much excellent farm land and many industrial cities, live more than 17,600,000 people. They have had to endure many floods and know they will have to cope with floods in the future. Floods are becoming more frequent in this region and higher in their crests. That of 1937 was the worst on record. It directly affected 243 counties in 10 States and obliged 648,000 people to flee. The financial losses were enormous. Formerly about 98 percent of the Ohio River Basin was in forest but now only about one-third bears forests, and this third is rough land unsuited to cultivated crops. For decades it has been heavily cut, repeatedly burned, and overgrazed. There is no doubt that better forest protection and management in the region, accompanied by reforestation of areas suitable for the purpose, would help to lessen the flood hazard.

National forests comprising 16,500,000 acres are planned in the Ohio River drainage basin, though as yet only 2,900,000 acres have been acquired for the purpose. Most of the forest land in the area is in private ownership. Better forest management of both the publicly and privately owned forest land of the basin would lighten the pressure of flood waters on the engineering works down stream. Levees, dams, and other engineering works downstream are indispensable. On cultivated lands, strip cropping, contour cultivation, and terracing will help. But to reduce the height and strength of the floods significantly and to keep sand and silt from clogging channels and reservoirs, farm woodlands and other privately owned forest lands in the Ohio basin should be rebuilt, forest and forage crops should be harvested rather than exploited, and the public acquisition of forest land should be speeded up. This is also true of forest areas that influence other important streams.

Grazing in National Forests

Administration of grazing in the national forests is a responsibility of the Forest Service; for grass and browse, intermingled with timber on higher portions of many watersheds, is vitally important. In allocating grazing privileges in the national forests of the West, the Forest Service makes an analysis of range and crop conditions in selected and representative areas, and emphasizes conservation through planned and correlated range uses. It endeavors to correlate the economic aspects of grazing in the national forests with the traditions and the social needs of each community. On 83,000,000 acres of national-forest lands graziers annually pasture, for parts of each year, some 1⅓ million cattle and horses and nearly 5⅔ million sheep. Proposed changes in grazing policy are made only after livestock associations and other interested agencies have had a chance to consider them. In territory near the western national forests there are 763 cooperative national-forest associations. Their deliberations play a very real part in shaping range programs; their annual and other meetings represent a close approach to successsful cooperative range management and administration.

At the request of the Agricultural Adjustment Administration, and in cooperation with it, the Forest Service acts in a technical and advisory capacity in a range-conservation program. During the year it assigned experienced men to the job of determining private-land range capacity and acceptable grazing practices, and examined some 56,000,000 acres of range. It suggested and helped to develop a manual of Technical Instructions for Range Surveys, which has been approved and adopted as standard by the Soil Conservation Service and the former Resettlement Administration of this Department, and also by the Grazing Division and the Indian Office of the Department of the Interior.

Formulation of Grazing Policies

One of the most perplexing problems in national-forest administration is that which has to do with the distribution of the range resources, for in most localities the demand exceeds the supply. Therefore the Forest Service undertook a survey of economic and other problems involving the allocation of national-forest grazing privileges. The survey was started on a representative national forest in each of the six western regions. For a great many years there had been a growing realization of the need for additional information on which to base the determination of policy on such questions as land dependency, commensurability, protective and maximum limits, permittee qualifications, and other problems of importance in range management and range administration. In some instances, administrative action under existing policies had seemed to certain permittees to carry implications of arbitrary action, and local range administrators had felt the need for information which would serve as a tangible measurement of the various factors that decide for or against an applicant for range privileges. It was with these things in mind that the Forest Service undertook the study.

WILDLIFE RESTORATION

In the wildlife-restoration program, the Bureau of Biological Survey devoted $1,123,051 to the purchase of land for refuges, and added an area of 619,244 acres. Reservation from the public domain further increased the total refuge area by 1,874,300 acres.

Among the refuges established during the year are: Sacramento Migratory Waterfowl Refuge, Calif. (10,776 acres); Bombay Hook Migratory Bird Refuge, Del. (12,006 acres); Okefenokee Wildlife Refuge, Ga. (293,815 acres); Moosehorn Migratory Bird Refuge, Maine (11,293 acres); Mud Lake Migratory Waterfowl Refuge, Minn. (60,216 acres); Swan Lake Migratory Waterfowl Refuge, Mo. (12,336 acres); and the Fort Peck Game Range, Mont. (970,000 acres).

All told, the Biological Survey now supervises 234 bird refuges aggregating 6,473,938 acres (including 14 tracts of 9,791 acres used for experimental and administrative purposes). It also administers 11 big-game preserves and ranges aggregating 5,018,227 acres. In an easement-refuge program in North Dakota and Montana landowners have turned over to it 75 areas with an aggregate acreage of 118,777 for administration and developement as projects for conserving wild fowl and water.

Most of the purchases since 1933 have been on submarginal areas or in drought regions. They have contributed to the general program of land rehabilitation. In developing the areas the Biological Survey has had the help of the Civilian Conservation Corps, the Works Progress Administration, and the National Youth Administration enrollees.

The restoration of wildlife valuable for fur, meat, and sport helps to increase incomes. The fur catch in the United States is worth $60,000,000 to $70,000,000 annually. Hunting privileges on large tracts, especially in the Southeastern States, are leased at yearly rates varying from 10 to 20 cents an acre. Many large estates are devoted primarily to game production. Colleges are paying more attention to wildlife research, and the States are employing wildlife administrators and protectors.

The gun, ammunition, camera, and sport-clothing and sport-accessory businesses are of considerable proportions. Hunters, camera enthusiasts, and tourists lured by wildlife make business for automobile manufacturers and dealers, for service and filling stations, for railroads and busses, for hotels and tourist camps, and for guides and boatmen. There is trade also in plants for improving wildlife habitats and in seeds of plants that provide food for wildlife. Wildlife interests many people besides hunters.

Regulation of Hunting

The restoration and protection of wildlife requires careful regulation of hunting as well as the development of wildlife habitat. Such protection by the Federal Government is now afforded more species than ever as a result of a convention between the United States and the United Mexican States signed at Mexico City on February 7, 1936, and proclaimed by the President on March 15, 1937, following exchange of ratifications by both countries. Observance of the regulations has been advanced by the fact that courts have imposed the maximum fine of $500 on some violators and jail sentences on others.

Investigations on which the Federal hunting regulations are based have been extended into Canada and Mexico. With the assistance of the Army, the Navy, the Coast Guard, the Bureau of Marine Inspection and Navigation, State conservation agencies, and private individuals, the Biological Survey made an inventory on all the important waterfowl-concentration areas in the United States. The results, with observations on breeding grounds, indicate that the waterfowl program is succeeding, and that the decrease in several species of these birds has been stopped.

One result is the present status of the trumpeter swan on the Red Rock Lakes Migratory Waterfowl Refuge in Montana. This is a magnificent bird, the largest of North American wild fowl. Only a few years ago it seemed on the verge of extinction. Conservationists have been delighted to learn that there are still 158 of them known to be in this country. This number represents an increase of 43 birds, or more than 37 percent, over the known number last year. The elegance of the swans, their wildness, and their loud, sonorous calls make them uniquely interesting.

The Red Rock refuge is used by more species of waterfowl than any other Federal refuge; but it is valued most highly because the trumpeter swans are there. Their human guardians work as carefully as nurses where life hangs in the balance. From the time the ice leaves the lakes until the young birds are fairly grown, no one may venture on the lakes where the birds nest. Even the refuge manager does not go on the nesting grounds. With the parent birds frightened away, the sun might injure the embryos; or if the sun were hidden, the eggs might be chilled.

The national wildlife-restoration program endeavors to protect other threatened species, some of them already close to extinction. The measure of success attained in restoring the trumpeter swan gives hope for these other species.

Controlling Diseases of Wildlife

As a means of controlling diseases among wildlife, the Department in establishing wildlife refuges has avoided as far as possible the selection of sites that are subject to pollution and has cooperated with other agencies in efforts to lessen the pollution of streams, marshes, and lakes. It has pushed various studies of the diseases of waterfowl, quail, grouse, and deer. Other research projects aim to reduce the factors that favor the spread of parasites and infections on fur farms and refuges, and elsewhere. Programs for predator and rodent control protect livestock, game species, and agricultural interests, and help to control disease as well. Bubonic plague, Rocky Mountain spotted fever, tularemia, infectious jaundice, typhus, rabies, and other diseases may spread to man and to wildlife from predator and rodent hosts.

Marshlands produce wild birds and mammals, many of which have great economic value. But they breed mosquitoes. This problem has engaged the attention of the Bureaus of Biological Survey and Entomology and Plant Quarantine of this Department and public-health agencies. It is possible to control mosquitoes by draining marshes. Improper drainage of marshes, however, may destroy their value for waterfowl. Scientists in this Department are studying biological, chemical, engineering, and other means of mosquito control that may prove as effective as drainage and less objectionable as regards wildlife. On tidal marshes mosquito breeding can often be

reduced by the use of sluices, dikes, and tide and spill gates for controlling the water level. Killifishes, top minnows, and other predatory enemies of mosquito larvae help in mosquito abatement. Permanent ponds on salt marshes rarely provide a suitable breeding environment for mosquitoes, and as a rule need not be eliminated in mosquito-control operations.

The fur trade now concedes that ranch-raised pelts, against which it discriminated a few years ago, are superior to nature's product from animals trapped in the wild. Above 98 percent of the 200,000 or more silver fox pelts marketed annually in the United States are from animals raised in captivity. Research by the Biological Survey, at the United States Fur Animal Experiment Station in the Adirondacks, has helped greatly to put the raising of these and other fur animals on a sound commercial basis.

RESEARCH IN DAIRY PROBLEMS

The problem of utilizing roughage crops to the best advantage for milk production is uppermost in the minds of many dairy farmers. Soil-conservation programs have increased the supplies of roughage on many farms; feeding investigations have shown the economy of feeding good-quality roughage to the limit of the cow's capacity; extension services have emphasized the benefits of grasses and legumes for improving the soil as well as for economical milk production; and the droughts of recent years have indicated the importance of carrying sufficient feed from one year to the next.

Research in the Bureau of Dairy Industry has shown the need for good quality in roughage, and developed fundamental principles in harvesting, curing, and storing roughage crops to preserve their valuable nutritive properties. It has shown that grasses and legumes harvested in the immature stage of maturity are more palatable than mature crops. The immature crops have a higher percentage of protein and less crude fiber, and are more effective in maintaining a good milk flow.

Grasses harvested at an immature stage can be made into hay equal for milk production to the best grades of commercial alfalfa hay. Immature or green plants contain more carotene than mature plants. Dairy cows must have an adequate supply of carotene (the substance from which vitamin A is made in the animal body) to produce a normal milk flow, and maintain their health and reproductive functions. Roughages are the principal source of carotene in the usual dairy ration, and dairy farmers can profit materially by handling and storing these crops so as to preserve the carotene.

When a crop can be made into a good-quality hay, there is little or nothing to be gained, from the standpoint of improving the quality of the feed, by making the crop into silage. Certain conditions, however, frequently make it more desirable to store a grass or legume crop in the form of silage rather than in the form of hay. Recent investigations indicate that any green crop can be preserved in the silo without spoilage, and with only a small loss in food nutrients, if the air is forced out of the silage mass promptly and kept out. The composition, palatability, and feeding value of a silage is much the same as that of the crop from which it was made. For this reason immature grasses make better silage than mature

grasses, and on the other hand weeds and other unpalatable materials cannot be made into palatable silage.

Dairy Animal Recording

The Bureau of Dairy Industry in cooperation with State agencies and farmers began during the year a Nation-wide program for recording the identity, family history, and production records of all animals in dairy-herd-improvement associations. This is an outgrowth of 30 years of cow-testing association work, and many years of research in the breeding of dairy cattle. Breeding experiments have demonstrated that the surest and quickest way to develop strains of uniformly high producing cattle is by the use of a good proved sire in each successive generation.

To apply the proved-sire system of breeding on a large scale among the average herds of the country it seemed advisable to start a concerted effort to find large numbers of sires that have demonstrated through their progeny that they transmit uniformly high levels of production. The dairy herd-improvement associations, whose members own approximately 400,000 cows and 17,000 bulls, afforded a promising source of production records for proving large numbers of sires. Accordingly, with the cooperation of the State dairy extension services, the Bureau arranged to file a record of the identity and production performance of every animal in these association herds.

Production records on every daughter of each association sire, and on the dams of the daughters, are now being filed with the Bureau as rapidly as they are available and tabulated automatically to prove the sires of the daughters. In the first year of operation, some 1,500 association bulls have been listed as "proved" by the records of at least five daughter-dam comparisons. Some of them proved good, some poor, and some just average in their ability to transmit an inheritance for good production. The accumulation of the data should make it possible to eliminate many poor sires from further use and to select worthy ones for more extended service.

EXTENSION SERVICE

Federal and State agencies for rural life improvement utilized the experience and the facilities of the Extension Service in launching and executing their programs in the States. County extension offices were focal points where agents and committeemen gave instructions and help. The agricultural conservation program, launched in March 1936, bore considerable fruit the first year, yet many farmers did not fully understand the details until after the planting season. Real fruition began in 1937, when the program came into full swing in all the States. It harmonized with the previously established extension program. The extension agencies had been teaching farmers how to maintain and build up soil fertility; how to keep topsoil from washing or blowing; and how to balance the farm program. Under the new program they worked with new impetus along familiar lines.

In the western range area, watersheds are fast coming under protection, water holes and springs are being developed, trouble areas are being withdrawn from grazing, ranges are being fenced, and forage plants seeded

to reestablish a sufficient vegetative cover. Extension agents are helping to direct these operations. In Texas, for example, about 3,800,000 acres of land on farms and ranches are being devoted to soil-building practices.

Funds available under the Bankhead-Jones Act of 1935 permitted many of the States to add to their extension staffs in 1936 and 1937. This especially aided home demonstration work. Extension workers advised farm homemakers in outlining proper diets; in managing the home to conserve the family budget; in plans for improving the home and its furnishings; in learning to buy wisely through knowledge of quality in materials and in workmanship; and generally in efforts to promote family welfare. A national specialist in parent education was appointed to meet a demand from rural people for assistance in such educational projects.

The Extension Service cooperated with other Federal agencies, including the Farm Security Administration, the National Youth Administration, the Farm Credit Administration, and the Federal Housing Administration. It cooperated with the Rural Electrification Administration in aiding farmers to obtain desired power facilities to drive farm motors, light homes and farm buildings, and operate other electrical devices. It helped farmers to determine what would be advantageous electrical equipment. It cooperated with the Soil Conservation Service in educational programs. County agents and specialists aided farmers in building check dams, terraces, revetments, and in planting grasses and trees to control erosion by water and wind.

Committeemen and leaders in the counties took over more of the routine work in the agricultural conservation program, and gave the extension agents more opportunity to follow up farm efficiency programs. They helped in organizing herd-improvement associations; in obtaining better sires for flocks and herds; in promoting the keeping of records of performance; in seed selection; in the treatment of seed to free it from disease, pests, and foreign materials; in planning home building and maintenance; and in devising better shelter for the livestock, and better sheds for machinery and equipment. Georgia reported that treated cottonseed produced 50 percent more cotton than untreated seed. Improved staple in Alabama cotton gave the growers an additional $3,000,000, and fertilizing added another $3,000,000. Sugar-beet growers in Colorado, Utah, California, Michigan, and Nebraska saved millions of dollars by planting disease-resistant beets. Improved varieties of corn, wheat, barley, oats, and grasses augmented the national farm income.

Extension workers aided in all these activities and in the war against animal and plant diseases and pests. They fought the Japanese beetle in Delaware, tobacco wildfire in Pennsylvania, scab in the orchards of Indiana, grasshoppers in North Dakota, the screwworm in Florida, cut ants in Texas, cotton leaf worm in the Cotton Belt, botflies in Missouri, cotton wilt in Georgia, crickets in Utah and Idaho, chinch bugs in Illinois, prairie dogs in the Plains and range States, and citrus fruit and garden pests and diseases on the Pacific coast. New Hampshire agents formed a 90 Percent Clean Apple Club. Extension agents cooperated in the eradication of Bang's disease in cattle, in the testing of chickens for pullorum disease, and in weed eradication, for which purpose they distributed 5,000,000 pounds of poison.

Other extension activities dealt with discussion groups, reading circles, lectures, and tours. When areas along the Ohio and the Mississippi were

flooded, extension workers rendered service with rescuing agencies through their knowledge of the region, of the location of rural families, of crops and livestock in the path of the flood waters. They also procured and prepared food for refugees, organized groups to gather and distribute supplies to the destitute, and cared for the sick. The Extension Service worked during the year in practically every State among "the older youth group" to help them take their place in adult life. Work with Negroes was an important part of the extension plan in the Southern States. In Oklahoma, for example, 7,500 Negro farm families cooperated, and nearly 3,500 Negro boys and girls enrolled in 4–H clubs.

Increased appropriations and additional experienced personnel aided extension work in Hawaii, Alaska, and Puerto Rico. Advances in Hawaii were principally in diversified production, subsistence gardens, agricultural economics, and the grading and packing of vegetables. In 1936, 1,500 well-bred dairy cattle and 8,500 White Leghorn fowls were shipped into Alaska. Women in Alaska are demanding more work in the extension program. In Puerto Rico the program centered around remedying diet deficiencies through improved dairy and beef production and the growing of well-planned gardens.

FOOD AND DRUG ADMINISTRATION

The Federal Food and Drugs Act of January 30, 1906, became effective January 1, 1907. Its passage climaxed a long struggle waged by legislators, Federal officials, by State food-law enforcement officers, and by public-spirited representatives of the consumers and of reputable industry. Thirty years of enforcement have demonstrated it to be a most beneficent piece of legislation. Nevertheless, though the measure represented a vast advance in public protection, it was admittedly a compromise, imperfect in many respects, and its imperfections have become more apparent in the light of court decisions and of modern commercial developments, which could not have been fully anticipated at the time the law was passed.

The law has been effective in eliminating from the interstate market many of the grosser and more obnoxious forms of food adulteration and misbranding. It has forced a moderation of the label claims of many of the nostrums of the cure-all type. Enforcement of the act has given the United States better protection of its food and drug supply than most other civilized countries have. Yet this is not cause for extreme satisfaction.

In many respects the law is inadequate. It affords no control of cosmetics and curative devices; it contains no prohibitions against false advertising; it sets up no authority for the establishment of legal standards for food products; it contains a defect that practically nullifies governmental efforts to control certain worthless remedies offered for serious disease conditions, and another that offers a loophole of escape to a large group of adulterated and misbranded food products.

These and other shortcomings led the Department early in 1933 to urge the enactment of an improved law. The proposed legislation has been continuously before Congress for 4 years. Meantime, the Department has urged that more funds be appropriated for the enforcement of the existing law. Better protection could be furnished notwithstanding the imperfections of the measure. Funds for Food and Drugs Act enforcement have

been materially increased during the past 3 years. But the difficulties have increased also. Growth in population and in interstate traffic, particularly in interstate truck traffic in foods and drugs, have prevented the increased appropriations from keeping up with the enforcement problem.

Jurisdictional Limitations

Another circumstance has complicated the problem. Under the present statute, the Food and Drug Administration must contend with certain jurisdictional limitations. It is important to seize and destroy food products that consist in whole or in part of filthy or decomposed animal or vegetable materials. Food factories can free their output from objectionable conditions of this kind only by the most scrupulous care, by the selection of sound and wholesome raw materials, and by the maintenance of unexceptionable sanitary conditions. The law authorizes action against the output of factories known to be operating in a filthy and insanitary manner only if the presence of filth or decomposition in interstate shipments of their products can be proved. This is often extremely difficult. Most food processors observe hygienic practices, but some do not.

They do their manufacturing in such unwholesome surroundings that they should not be permitted to sell food products. The conditions in such plants may be known; yet it is frequently impossible to establish, by any scientific method so far developed, that the food product itself, as it moves in interstate commerce, is filthy or decomposed. Therefore no action can be directed against the product or against the responsible shipper.

In the legislation now under consideration by Congress, this difficulty would be obviated. The law would declare a food product to be adulterated if it had been prepared, packed, or held under insanitary conditions, and exposed to possible contamination with filth. Amendment of the law in this way would greatly reduce the difficulty and cost of its enforcement and would guarantee better public protection, without imposing hardship on any reputable manufacturer.

FEDERAL HIGHWAY PROGRAMS

The Department administered a broadened program of highway construction during the fiscal year. It included the construction of new surfaces and the further improvement of existing surfaces on main highways, the construction of secondary roads reaching into farming areas, the extension of the main system into and through municipalities, the improvement of roads in Federal areas, and the elimination of railroad-highway grade crossings.

The year's work resulted in the completion of 27,488 miles of highways, roads, and trails, and the elimination of 1,149 grade crossings. Most of this work was done with Federal funds administered solely by the Department; in fact, 23,933 miles were in this classification. The remainder consisted of 169 miles of national-park roads built for the National Park Service by the Bureau of Public Roads, 1,901 miles of loan-and-grant projects of the Public Works Administration, also supervised by the Bureau of Public Roads, 1,479 miles of work-relief projects, on which labor and materials were supplied by other agencies and supervision was furnished by the Bureau of Public Roads and several State highway departments,

and 6 miles of road damaged by floods reconstructed with funds provided by the Works Progress Administration and State or local funds.

The Department administered funds provided as direct grants to the States for relief of unemployment through highway and grade-crossing work, as well as Federal aid to the States for highways. In both classes of work the Department cooperated with State highway departments. Federal-aid funds were matched as usual with State funds. During the year 11,358 miles of highways were completed with emergency funds and 7,180 miles with Federal-aid funds. Other work consisted of the reconstruction of 27 miles of flood-damaged roads and 246 miles of public-lands roads. Also, the construction of 139 miles of forest highways supervised by the Bureau of Public Roads, of 3,328 miles of forest development roads, of 1,540 miles of forest trails, and of 115 miles of minor forest highways handled by the Forest Service was completed.

In all classes of projects the current program at the end of the year involved a total of 17,909 miles. It comprised 2,897 miles financed with emergency funds, 10,451 miles of Federal-aid road, 453 miles of forest highways, 98 miles of public-lands highways, 85 miles of reconstruction of flood-damaged roads, 401 miles of national-park highways, 1,992 miles of loan-and-grant projects, and 1,532 miles of work-relief roads. (In the last three classes, and on 32 miles of reconstruction of flood-damaged road, the Bureau of Public Roads supervised the work for other Federal departments.) In addition many miles of forest roads and trails are being constructed and improved by the Forest Service.

Elimination of Grade Crossings

In the program for the elimination of hazards at grade crossings, with remaining portions of the $200,000,000 of works program grade-crossing funds authorized in 1935, 1,086 crossings were eliminated, 196 crossing structures were reconstructed, and 216 crossings were protected with signals or other safety devices. Work done with other funds brought the total crossings eliminated to 1,149 and crossings protected to 574. At the end of the year 876 crossings were being eliminated, 922 were being protected, and 151 crossing structures were being reconstructed.

Employment for the year on work supervised by the Bureau of Public Roads was 1,792,760 man-months, or the equivalent of an average full-time employment each month of 149,400 men. The number of individuals actually employed, some of them on a part-time basis, averaged approximately 209,000 persons per month. Employment that resulted indirectly from this work, as for example in the production and transportation of equipment and materials, amounted to about 1.6 times the direct employment. The estimated indirect employment was 2,868,000 man-months. Added to the direct employment, this gave a full-time employment of 4,661,000 man-months, the equivalent of the full-time continuous employment of 388,400 men.

Federal Highway Requirements

The first effort at large-scale highway planning—the designation of the Federal-aid highway system—has been entirely successful. This system, which includes 227,000 miles, or approximately 7 percent, of the rural road mileage, is now almost entirely surfaced. But it is not nearing com-

pletion. Wider and better surfaces are needed; many locations that are dangerous under modern traffic conditions must be made safe. Grade crossings that delay traffic and take an annual toll in lives must be eliminated.

Many sections of the most important Federal-aid routes are being widened to accommodate four lanes of traffic. Improvements are located in accordance with clearly indicated traffic needs, which include the improvement of main traffic arteries in the vicinity of large cities, the bridging of large and small streams, the elimination of various highway dangers, and the placing of all kinds of surfacing.

Highway traffic flows from every place of production or of habitation—from farm, factory, and home. Small streams of traffic converge into main streams. Roughly the Federal highway system resembles a network of waterways; but the analogy is not complete, because the Federial-aid system, unlike rivers, makes up a complete interconnecting system. Still another difference is that the individual units that compose highway traffic do not flow on and on. Short trips predominate, even in those States with the heaviest tourist traffic. However, the country's need for highway transportation cannot be met by any system less comprehensive than the Federal-aid system. The entire system and such additions to it as may be desirable must be raised to the standards required by present traffic.

Improvement of the system will not meet all our needs. There are other requirements. Originally Federal-aid improvements were confined to rural roads. But the worst bottle necks to traffic were not the unimproved rural sections. They were inadequately improved approaches to cities, and congested sections through cities without bypasses. Federal policies were broadened a few years ago to include this class of work.

Also, it is necessary to improve secondary or feeder roads, and the Federal Government has begun to do so. A large mileage of these roads was improved as a part of the emergency program to provide employment. In a new program for which $25,000,000 has been provided for each of the fiscal years 1938 and 1939, projects will fit into a coordinated system of secondary roads. Such a system will be designated as soon as studies enable the best possible selection of routes.

New Aspects of Highway Problem

The highway problem constantly reveals new aspects. It is important to make all roads as safe as possible, to improve main through highways to meet the needs of traffic, to solve perplexing traffic problems where main highways pour their traffic into cities, and to improve secondary roads rapidly enough, and with such a selection of routes, that a good system of secondary roads will be completed in a reasonable number of years. Attention must be given to all these highway needs. Concentration on one class of work, to the neglect of others, will mean that within a few years policies must be changed, and funds devoted to the kinds of improvement that have been passed by.

Highway problems have become so complex that State highway departments must plan their work on the basis of carefully gathered facts. They must have complete knowledge regarding existing roads and their condition of improvement, the movement of traffic, the amounts spent on highway improvements, and the sources of the funds. Getting such facts for all the

highways in a State is a big job. Details must be obtained on the condition of every mile of road, traffic must be counted, information must be obtained regarding the purposes of travel, its origin and destination, and the commodities hauled. Besides information regarding the sources of highway funds, it is important to have particulars as to the purposes for which they will be spent. Investigations must determine if the highway-tax burden is fairly distributed.

The Department, acting through the Bureau of Public Roads, is now cooperating with 44 States in conducting highway-planning surveys. When the surveys are completed we shall have, for the first time, a picture of the complete highway situation and be in a position to plan future improvements on a sound basis.

HENRY A. WALLACE,
Secretary of Agriculture.

O

REPORT OF THE CHIEF OF THE BUREAU OF AGRICULTURAL ECONOMICS, 1937

United States Department of Agriculture,
Bureau of Agricultural Economics,
Washington, D. C., October 28, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I transmit herewith report of the work of the Bureau of Agricultural Economics for the fiscal year ended June 30, 1937.

Sincerely yours,

A. G. Black, *Chief.*

CONTENTS

Nineteen thirty-seven is the fifth successive year of agricultural economic recovery. Farm income has been increased, farmers' debts have been reduced, farm real estate values are the highest in 6 years. The economic improvement has been widely distributed as prices of farm products during the first 9 months advanced to highest figures for the recovery period.

In contrast with the reduced crop production in 1936 is the near-record outturn of 1937. Production of principal crops is estimated at only 1.5 percent below the all-time high volume of production in 1920. And as usual when production greatly exceeds the effective demand and there is threat of burdensome surpluses, prices of many crops have broken sharply. The domestic demand outlook, also, has become less satisfactory than at this time last year.

FARM INCOME RAISED

The Bureau's preliminary estimate of farmers' cash income from marketings of farm products and from Government payments during the 1937 calendar year is $9,000,000,000. This estimate was made in August. The cash income figure was $7,865,000,000 in 1936, it was $7,090,000,000 in 1935, and $4,328,000,000 from marketings in the depth-depression year of 1932.

About $1,000,000,000 of the estimated gain this year over last is from marketings of products, and the remainder from Government payments to farmers, chiefly for soil conservation. The increase from marketings will go chiefly to the producers of grains, fruits, tobacco, and dairy products. More than one-third of it goes to the wheat growers. In the case of the livestock producers the higher prices for their products have been offset by reduced marketings. Increases in income of truck-crop growers are offset by a decrease in income from potatoes.

As farm income has increased farm property has become more desirable and valuable. A 16-percent rise in farm real estate values during the past 5 years is revealed in the Bureau's annual surveys and supplementary data. As of March 1 the value per acre, as a national average, was within 15 percent of pre-war figures. There doubtless has been a further gain this year. The farm real-estate market has shown greater activity. Voluntary sales and trades have increased; forced transfers on account of mortgage debt or tax delinquencies have decreased. And as values have gone up and mortgage debts been reduced farmers' equities have increased.

MORTGAGE DEBT REDUCED

A study made in cooperation with the Bureau of the Census revealed a decline in the estimated total farm-mortgage debt of farmers, from $9,214,278,000 in 1930 to $7,645,091,000 in 1935—a reduction due largely to debt liquidation through foreclosures and related distress transfers on mortgaged farms. This study has revealed, also, a marked shift in the farm-mortgage holdings of various lending agencies. Whereas on January 1, 1928, the Federal land banks held about 12 percent of the estimated farm-mortgage debt, on January 1, 1935, the amount held by these institutions and the Land Bank Commissioner was nearly 33 percent of the total.

In 1928 the life insurance companies were the most important group of farm-mortgage lending agencies, holding nearly 23 percent of the total estimated debt, but by 1935 the holdings by this group amounted to only 16 percent of the total. Banks held in 1935 a slightly smaller percentage of the total than in 1928. And the relative importance of individuals as a source of farm-mortgage credit also declined. The Bureau's studies reveal that about 35 percent of all farms as of January 1, 1935, were mortgaged. About 42 percent of the farms operated by owners and about 25 percent of the tenant farms were so encumbered.

Surveys have shown also a progressive decline in personal and collateral loans to farmers by commercial banks, the total held by insured commercial banks at the end of 1936 amounting to $593,614,000, or 26 percent less than at the end of 1934. The loans at the end of 1936 were less than one-sixth the amount held at the end of 1920 when the total was estimated at $3,869,891,000. The reduction since 1934 represented mainly the repayment and refinancing of carry-over loans. Loans made for current purposes do not appear to have decreased in volume.

Studies of short-term credit by country banks were made in Wisconsin and Utah. They lead to the conclusion that the future serviceability of country banks as sources of agricultural credit depends largely on finding a means of protecting banks against excessive shrinkages of deposits. Were this accomplished, the slowness of payment of loans for the purchase of land and for land improvements, and loans for the purchase or maintenance of work animals and dairy herds would involve much less risk to banks than formerly.

A study dealing with demand deposits of country banks was completed and published as a technical bulletin. It showed that deposits in recent years have risen more rapidly than either farm prices or farm income, reflecting in part receipts by farmers in connection with Federal rehabilitation, drought relief, and other emergency measures. In addition the refinancing of debts of farmers and home owners, when the loan proceeds have been used in payment of locally held debt obligations, has increased the flow of funds.

PRODUCTION COSTS RISING

During 5 years of agricultural recovery since 1932 the costs of farm production increased less than the gains in farm income. But costs are rising more rapidly now, as is indicated by various indices. Farm taxes are rising; farmers will have paid about $100,000,000 more for feed, seed, and fertilizer this year than last; farm machinery and repair costs are higher; farm building costs are

up; practically all harvesting costs are up; farmers' pay rolls for hired farm labor are up about $100,000,000. This year's production will cost farmers about $500,000,000 more than in 1936.

Cost-of-production studies have revealed a steady increase in the cost of producing corn, wheat, oats, and cotton during the past 5 years, but the increase in cotton costs has been less marked (due in part to relatively good cotton yields) than in the case of corn, wheat, and oats. Cost studies and the measurement of net returns to farmers are continuing Bureau projects. During the past year reports were issued on costs of production of potatoes, citrus, and 14 truck crops.

Farm real estate taxes per acre also are showing a distinct tendency to rise, following decreases each year from 1930 to 1934. The upswing appeared in many of the 1935 levies the country over, and became more general in 1936. The increase so far has been slight, but it is expected to carry further. On the other hand, farm land values have risen more rapidly than farm real estate taxes since 1934, with the result that taxes per $100 of true value have declined.

LONG-TIME PROGRAM NEEDED

But while the economic gains of the past 5 years are distinct marks of progress, there are still many economic and social problems in agriculture which press for solution. The menace of recurring surpluses and of consequent economic losses has not been removed.

A situation in point was the need this fall for Government action to stem the tide of shrinking cotton prices resulting from the production of an 18,000,000 bale crop of cotton. And this year's gain in the income of wheat growers was largely the fortuitous result of relatively small harvests outside the United States. The whole situation as to cotton, wheat, and other farm commodities has emphasized anew the need for a long-time agricultural program that will free farmers and the Nation from widely fluctuating supplies and prices of farm products.

The control programs inaugurated by the Agricultural Adjustment Administration and later invalidated by the Supreme Court sought to achieve this by preventing the burdensome accumulation of surpluses. The surpluses accumulated in preceding years were moved into consumption and their depressing effect upon prices of current crops lessened. But now burdensome surpluses again loom as a check upon economic recovery.

CROP INSURANCE STUDIED

It must be obvious that the economic unbalance of agriculture cannot be righted by spasmodic emergency action alone. A permanent program must be worked out in the national interest to offset by means of crop insurance, granary, or other systems the vagaries of nature in alternately making and destroying crops. A few seasons of excessive production or a few seasons of heavy crop losses might well mean the loss of much of the economic gain which has been won by farmers in the past 5 years.

The possibilities of crop insurance as a means of protecting farmers against excessive crop losses were extensively explored by the Bureau during the past year. The experience with crop insurance in foreign countries and the history of crop insurance by commercial agencies in this country were studied. Conferences were held with insurance agencies, warehousemen, and others as to the practicability of various proposed systems of crop insurance. It was concluded that the most effective plan would be that of writing insurance on the basis of a percentage of the average yields on individual farms.

Statistical research in crop insurance was applied principally to wheat. It involved primarily the computation of county-average figures for the amount of insurance in bushels per acre and the amount of the premium that would be required in bushels per acre. These figures have been computed from samples selected from individual farm yields reported by farmers who participated in the wheat-adjustment program in about 1,650 counties the country over, and from county-average yields as revealed by the records of the Crop Reporting Board. A beginning has been made in similar research on cotton, covering more than 200 counties, and on corn, covering more than 100 corn-producing counties or districts.

AGRICULTURAL ADJUSTMENT

As in 1936, the keynote of the Bureau's work in farm management was agricultural adjustment, with especial emphasis upon soil conservation. New projects in cooperation with State and other Federal agencies dealt with farm organization and soil management in 44 States; farm tenancy in relation to agricultural adjustment in 8 States, and range management in relation to range distribution policy in 5 States. Special reports of results were made available to cooperating agencies.

A series of cooperative studies was made in selected soil-conservation problem areas, with regard to soil and water conservation practices and their relation to farm organization, farm management, and farm earnings. In five Corn Belt States cooperative studies were continued to determine the effects of the agricultural conservation program upon farm practices, especially with reference to livestock production and farmers' incomes.

Cooperative studies in four New England States dealt with feed production and feed-buying adjustments that make for permanent and profitable livestock farming in the Northeast. In New Hampshire a cooperative study was started late in the fiscal year to determine the influence of the agricultural-conservation program on farm operation.

A cooperative study was started in Minnesota, dealing with the earnings and financial progress of rehabilitation clients of the Resettlement Administration. A series of publications was issued jointly with the Resettlement Administration dealing with rehabilitation problems in the drought area of the Great Plains region. Studies of agricultural adjustments in Texas and South Carolina were continued in cooperation with the respective State agricultural experiment stations.

Other cooperative research included a reconnaissance survey of problems involved in a better utilization of national resources for wildlife production; and a study of the efficiency of dairy farming in various parts of the country. About 1,400 dairy-farm record books were distributed to dairy farmers in 13 States.

Studies of yields, prices, and returns of apple varieties in the Shenandoah-Cumberland and neighboring apple-producing areas were continued in cooperation with the Farm Credit Administration. Type-of-farming studies were continued in eight States. Other research and service work included plans for the development of farms on two Resettlement Administration projects in Texas, and the completion of reports dealing with the organization and operation of farms operated in connection with schools and sanatoriums of the Indian Service.

Studies of interregional competition were directed toward finding the highest income opportunities for the use of the resources of a given area. Since the adjustments necessary for an area to avail itself of its highest income possibilities must be largely brought about through decisions of individual farmers, the emphasis is on the competitive position of different types of operating units. Sample areas in New England and the Midwest which represent different conditions in dairy farming have been selected for special study.

An analysis of records from individual farms together with supporting information in nine Midwest dairy sections indicated that participation in the agricultural-conservation program is not likely to reduce the total feed supply available for dairy cows in these sections. In fact, an actual increase in total feed nutrients seems more probable. This, together with improvement in the quality of the roughage, may more than offset the effect of the reduction in grain feeds. Consequently, there may be a slight increase in dairy production. Conservation payments are a significant item in the total income of participating farmers.

FARM-LIFE PROBLEMS

Each year the Bureau makes an estimate of the farm population. As of January 1 it was estimated that there were 31,729,000 persons on farms, or slightly fewer than on January 1, 1936. For the first time since 1929 the farm population had declined. The Bureau reported that 1,166,000 persons had left the farms in 1936, and that 719,000 had moved to farms from villages, towns, and cities. But the net migration off the farms was nearly offset by an excess of farm births over deaths; births were estimated at 716,000, deaths at 349,000.

It is likely there has been a further decrease this year in farm population, as suggested by the statistics on farm labor and industrial employment, but the total farm population is probably still above 31,500,000. The Bureau con-

siders the conditions under which many of these people live a major economic and social problem which must be studied and analyzed to afford a better foundation for rural improvement.

Through financial aid of the Resettlement Administration and the Works Progress Administration, it has been possible for the Bureau to expand much-needed research in rural life. Twenty projects, ranging from studies of the social status of farm tenants to studies of rural population mobility, were organized this year. The results of this work, besides aiding both the Resettlement Administration and the W. P. A. in putting agricultural rehabilitation and relief programs into effect, are being organized for publication in a series of 18 bulletins.

Rural-life projects completed during the year included studies of drought distress and of rural trends in depression years, the preparation of graphic summaries of American agriculture, revision of farm-population estimates for the years 1930 to 1934, revision of farmers' bulletins on rural hospitals and rural community buildings, comparative studies of American and foreign resettlement programs and policies, a survey of standards of living in Appalachian Mountain counties, and social planning in Coffee County, Ala.

At the close of the year there were in progress 10 research studies dealing with farm-population mobility, farm standards of living, disadvantaged classes in American agriculture, an analysis of rural-rehabilitation families, social aspects of farm-land tenure, an analysis of farm-labor conditions, a social analysis of the drought area, cooperative studies of foreign resettlement programs and policies, and the preparation of State estimates of farm population.

FARMERS WITHOUT LAND

The increasing army of landless farmers is another problem which presses for solution. The situation as to farm tenancy, particularly in the South, has become acute. More than 2,865,000 farms the country over are now operated by tenants as compared with 1,025,000 farms 50 years ago—an increase of 180 percent.

The problem of the landless farmer ties in closely with the need for a program of land utilization and the retirement of submarginal land. Responsibility for developing such a program was assigned to this Bureau on September 1 by the Secretary of Agriculture under authority of the Bankhead-Jones Farm Tenant Act, "to correct maladjustments in land use."

The Bureau's research in land economics during the year included the classification of various types and grades of land according to their best long-time economic use. Studies in this field were made for the Resettlement Administration, the Agricultural Adjustment Administration, and other governmental agencies. One project completed was the economic classification of land in 120 counties for the Resettlement Administration. Area analyses and classification are being continued in additional counties.

The Bureau has assisted the various agencies in local planning studies for the resettlement of land, and in the development of a long-time program of submarginal land acquisition by identifying the areas where such activity seems to be justified, and by assigning an order of priority for such acquisition. Other research has included studies of the origin, character, extent, applicability, and effectiveness of measures intended to bring about readjustments in the use of land, and to prevent its misuse.

Bureau economists believe that the zoning of districts or counties for specific agricultural uses may be an effective way to prevent the repetition of past abuses in the use of land. An example of the application of zoning is found in northern Michigan where an enabling act originally passed in 1929 was amended in 1935 to provide for the establishment of districts or zones within which the use of land, natural resources, and structures, and the height, the area, the size, and the location of buildings may be regulated by ordinance. A majority of the people in four out of six counties have voted in favor of these regulations.

Cooperative projects included technical aid to the Tennessee Valley Authority in connection with land-acquisition problems, the appraisal of land required by the War Department in connection with flood control in the Mississippi Valley, and the collection of data relating to farm-land transfers, farm-mortgage debt, and taxes on farm real estate from the official records in about 900 counties. The last-named project was sponsored by the Bureau and financed by an allotment from the Works Progress Administration.

THE HIRED MAN

Closely related to the farm-tenancy situation is that of farm labor. As farm mechanization has increased there are fewer farm-labor employment opportunities; in many instances hired hands have been replaced by tenants. Since much hired labor is largely seasonal, the wage hand does not have an annual income which will provide an adequate standard of living. Obviously, any program of agricultural rehabilitation and security must include the farm laborer, as well as the farm tenant and the farm owner.

But just where and how the farm laborer should participate in the agricultural program cannot be determined in the absence of fundamental research as to his economic and social status and opportunities. The Bureau issues monthly reports on farm wages and employment, and has published in the past the results of occasional scattered surveys dealing with farm labor. Other than this, little is known in detail of the conditions affecting an army of nearly 2,500,000 farm wage workers. Research should include studies of the labor supply and demand; of wages, hours of work, and costs of living; of seasonal farm-labor migration; of living conditions; and of the relations between employer and the employed.

FOREIGN MARKETS

Events of the past year have demonstrated the opportunities for recapturing foreign markets for our surplus agricultural products. Although agricultural production has continued to increase in the principal agricultural importing countries, none of these countries has attained complete self-sufficiency. Whatever degree of it has been attained has been due mainly to reduced consumption and, until this year, to better-than-ordinary crop yields. But the competition for foreign markets has become more severe as production has expanded in the surplus-producing countries—notably cotton in Brazil, China, and the Union of Soviet Socialist Republics, and flue-cured tobacco in China and India.

The Bureau's studies of cotton consumption in various foreign countries reveal a reduction during the past quarter century of more than 1,500,000 bales in the consumption of American cotton by British mills. A part of this reduction has been due to changes in the relative supply of American and foreign growths, but more importantly to the fact that mill consumption of all cotton in the United Kingdom has declined about 1,000,000 bales, or about 30 percent, during this period. The decline in total British mill consumption has been due mainly to expansion of the cotton textile industry in the Orient.

Increasing foreign competition in combination with the recent droughts in the United States and with remaining foreign-trade barriers have operated to reduce the volume of American agricultural exports. But production shortages in the United States cannot long continue, as was amply shown by this season's large production of food, feed, and fibers. And the foreign-trade barriers are being gradually broken down through reciprocal trade agreements.

The Bureau is actively assisting the Department of State in the foreign trade policy which seeks by means of reciprocal agreements to increase foreign purchasing power for our export products by admitting larger imports of foreign goods, and to break down the barriers which have played so important a part in the loss of our foreign markets. Trade agreements were concluded during the year with Finland, Costa Rica, and El Salvador, raising to 16 the number of countries with which trade agreements are now in effect. These countries are markets for about 25 percent of our total agricultural exports.

A development of vital importance to American agriculture was an extensive exploratory study intended to lay the groundwork for a reciprocal trade agreement with the United Kingdom. Such an agreement would provide vast additional outlets, since the United Kingdom in the past has represented a market for about 35 percent of our agricultural exports.

FOREIGN RESEARCH STRENGTHENED

In all fields of foreign agricultural research the Bureau's work was appreciably strengthened during the year. New projects included appraisals of the recent French wheat policy, the agricultural producing capacity of Germany, the expansion of cotton production in Argentina, recent developments in Soviet agriculture, the present and potential agricultural resources of Manchuria, and agricultural production in the Philippine Islands.

There were many special commodity investigations, including the production and consumption of tobacco in Europe and in the Far East, the European hog situation from the point of view of the outlook for exports of American pork and lard, trends of cotton production in India and east Africa, European requirements for unmanufactured cotton, the physical condition of American cotton arriving in European markets, and the British market for citrus fruits which compete with American fruits.

Through its foreign staff of agricultural commissioners and attachés located in key markets and important producing regions abroad, the Bureau keeps in daily touch with the foreign agricultural supply-and-demand situation. Besides providing basic information for use in economic research, the dispatches from these foreign correspondents are broadcast to farmers and the trade in the United States through the Bureau's Nation-wide system of news dissemination by press and radio.

Imports of agricultural products over a period of years were studied to determine their tariff status and competitive relationship to domestic agriculture. It was learned that about 54 percent of the total value of agricultural imports consisted of products that are noncompetitive with domestic farm products. Of the noncompetitive imports 99 percent of the value was in products free of duty. Of the competitive agricultural imports about 75 percent were dutiable. Further studies indicated that higher tariffs on many of these competitive commodities would have had a negligible effect on the prices of domestic farm products. But as to cotton, an analysis indicated that the 7 cents per pound import duty on long staples has effectively reduced imports and increased the price and consumption of American long-staple growths.

THREE HUNDRED RESEARCH PROJECTS

Besides its many activities dealing with the issuance of crop and livestock estimates, the collection and distribution of farm market news, the preparation of grades and standards for farm commodities, the inspection of products for grade and condition in trade channels, the analysis of agricultural price movements, and the administration of many laws, the Bureau had at the close of the fiscal year more than 300 economic research projects under way and in various stages of completion, many of them in cooperation with other governmental agencies or with State agricultural experiment stations.

These research projects deal with practically every commodity. They include investigations in agricultural finance, the marketing of cotton, the making of crop and livestock estimates, the marketing of dairy and poultry products, changes in agricultural commodity prices, farm management and costs, and farm population and rural life. They include surveys in foreign countries whose agricultural products compete with American products in world markets, research in land economics, and research dealing with the marketing of fruits, vegetables, grain, hay, feed, seed, livestock, meats, and wool.

Other Government agencies draw heavily upon the Bureau for basic data and economic research and analyses covering many subjects. It is called upon to supply members of Congress with the information needed in the consideration of agricultural legislation, and by many Government administrative agencies, from the Agricultural Adjustment Administration and the Farm Credit Administration to the W. P. A. It is called upon for information by many State administrative and legislative agencies, and does much research also in cooperation with State agricultural experiment stations and State departments of agriculture.

Requests from the Agricultural Adjustment Administration for statistical data and analyses during the year were in connection with marketing agreements, soil-conservation programs, and general policy planning. Many requests are received also from public and private agencies for information relating to the supply, demand, and prices for farm products, requests which involve the maintenance of several thousand different statistical series. (During the year the Bureau appointed a committee of its own statistical experts to analyze critically and to improve wherever possible its statistical research methods.)

In Government and private litigation the Bureau is called upon to furnish expert testimony, ranging from the certification of the quality and prices of products, to the preparation of economic briefs in connection with freight rate hearings before the Interstate Commerce Commission. Its testimony is sought

also at hearings of the Packer and Stockyards Administration in connection with applications for increases in yardage rates.

At the request of the Agricultural Adjustment Administration, exhaustive studies were made of the incidence of the taxes levied under the Agricultural Adjustment Act on the processing of cotton, tobacco, wheat, corn, rye, rice, hogs, sugar, and peanuts. Approximately $1,250,000,000 are potentially involved in processing-tax cases arising from invalidation of the act by the Supreme Court. Results of the Bureau's study are to be published by the Bureau of Internal Revenue.

CROP AND LIVESTOCK ESTIMATING

"Covering the drought" was the dramatic phase of crop and livestock reporting this year as the Bureau's full force of volunteer reporters and its field statisticians in the affected areas were organized to make possible the issuance of a series of special drought reports. In addition, more than 200 acreage, condition, yield, price, and other regularly scheduled crop and livestock reports were issued from Washington, and the usual quinquennial revisions made in the estimates of acreage, yield, and production of crops in each State. This process of revising estimates of preceding years in the light of new quinquennial census data is called by the statisticians "a major operation." It is complicated by many factors, it is statistical drudgery, but it must be done in the interests of statistical accuracy.

Work was begun on the collecting of statistics covering the production of chickens and eggs by large commercial farms so as to make possible the issuance of more complete poultry- and egg-production estimates; arrangements were made for getting additional records of carlot shipments of livestock and wool from the Western States, and of boat shipments of wool from Pacific coast ports; a new series of estimates of livestock numbers on farms by States, as of January 1, was prepared for all years back to 1867, and revised estimates of milk cows used as a basis for estimating milk production in earlier years.

For several years the Bureau has endeavored to meet the requests of vegetable producers and their organizations for estimates covering a wide variety of crops grown under greatly diverse conditions and sold either for fresh consumption or for canning. Funds for this work have been limited, and there is always the danger of spreading the work too thin.

With the aid of W. P. A. funds the Bureau was enabled to complete extensive surveys of fruit and nut trees by varieties and ages in California, Washington, Oregon, New York, and Virginia, so as to provide a more adequate basis for determining the probable trend of production by varieties in future years—a service which should give greater stability to fruit raising.

State estimates of tobacco production by types were compiled, back to 1919, and estimates for all types combined were revised, back to 1909. The cane-sugar estimates were made more useful by determining the actual sugar content of the raw sugar made and converting the current estimates from an "as made" to a uniform test basis. The estimates were extended to cover the expanding sugar industry of Florida. Preparations were made also to start estimates of the commercial production of peanuts.

A new series of estimates was compiled of prices which farmers of each State received each month from wholesale sales of milk, covering all years from 1910 to 1937. A series of estimates of the number of persons employed on farms was completed, and studies continued of weather data as related to crop production. The Bureau's regular crop reports were expanded to include a nontechnical discussion of prospective food and feed supplies.

A new development was the preparation of maps with which to supplement the crop reports. The maps are simply drawn to show crop or pasture conditions by counties, and frequently are flashed out by wire by the press associations for publication along with the crop reports.

As a result of the drought and consequent public concern as to the adequacy of the food supply, the Bureau issued two reports on this subject, one related to total supplies, and the other to per-capita supplies of a large number of foods.

In a food-consumption survey in New York it was learned that expenditures for meats and for dairy products are more affected by changes in income than are expenditures for cereals and vegetables.

INCOME PARITY AND PRICE ANALYSES

During the year the Bureau issued its annual estimate of income from farm production in 1935, preliminary estimates of cash income from farm marketings in 1936, monthly estimates of income from farm marketings, monthly estimates by States and regions of receipts from principal farm products, and indexes of income from farm marketings by groups of commodities.

A special research project entitled "Income Parity for Agriculture," was undertaken at the request of the Agricultural Adjustment Administration for use in analyzing the purchasing power of the net income per person on farms as compared with that of persons not on farms, during the 5-year period August 1909 to July 1914, and the period 1924 to date. This project has involved the collection of much original material relating to farmers' expenditures, the utilization of farm products, sources and amounts of nonfarm income accruing to farmers, the distribution of national income as between persons on farms and persons not on farms, and the cost of living of persons in farming and in nonfarming areas.

Besides reporting the prices of farm commodities, the Bureau seeks to evaluate the many factors of supply and demand which influence prices. Studies in this field during the year dealt with the factors affecting prices and production of livestock, the consumption and prices of cotton, and the prices of grain, poultry, eggs, fruits, vegetables, tobacco, and dairy products, and the development of new statistical techniques in price analysis and general economic research.

The price studies indicated that farm income from meat animals is affected chiefly by changes in income of consumers and changes in processing and distribution charges. (Charges for processing and distribution were relatively stable from 1933 to 1936, but increased materially in the first half of 1937.) As to variations in the cattle supply and slaughter, preliminary conclusions based upon a study of 35 years of records are that variations in cattle slaughter are associated with changes in feed and cattle prices; that variations in steer slaughter are associated with changes in the movement of cattle on feed and changes in range conditions in the Western States; and that variations in the slaughter of calves are related to changes in prices of dairy products and prices of veal calves.

Correlation analyses involved in the study of grain prices were brought up to date and revised, and weather and wheat-yield studies for Argentina and Australia were summarized and evaluated. New price analyses for corn were made, including an evaluation of the influence of wholesale prices and of the effect of market receipts on corn prices. It was found that the seasonal volume of receipts is not an important factor influencing the seasonal trend in corn prices. New price analyses for oats showed that annual variations in the price of this commodity are associated with changes in the supply of oats and the general price level.

Outstanding facts developed in studies of prices of fruits and vegetables are that the crop-year average price of each major fruit and vegetable is dependent largely upon the supply of the given commodity and the level of income of consumers, as measured by the index of incomes of industrial workers. No statistical evidence was uncovered that important price changes were due to competition between fruits or vegetables, except in the case of sweetpotatoes.

OUTLOOK REPORTS

In the fall of 1936 the Bureau issued its thirteenth annual Outlook Report, summarizing the principal facts and conclusions dealing with the domestic and foreign demand for farm products. It summarized the situation and outlook as to cash crops, feed crops, livestock, and livestock products. It discussed the probable course of farm prices and farm costs under given combinations of economic conditions.

The outlook work during the last 13 years has been developed into a broad agricultural extension program designed to aid farmers, the agricultural extension services and administrators of adjustment, security, and conservation acts in planning production and marketing programs. It consists essentially of assembling, analyzing, and interpreting basic information dealing with the many economic factors which may affect the prospective demand for farm products.

24871—37——2

The reports, each fall, are completed in cooperation with representatives of the State agricultural colleges and of other Government agencies concerned with agricultural economic adjustment and advancement. They are made available for the use of extension and other workers in developing local, regional, and national agricultural programs. A summarized outlook report in condensed and popular form for practical use by farmers direct is also issued.

A valuable part of the outlook work is the preparation of charts which depict as in no other way the relation of economic forces in their current and future effects upon the various agricultural industries. They are distributed among county agents and other extension workers for use in connection with State and local agricultural planning programs and outlook meetings.

DISTRIBUTION METHODS STUDIED

Changes of far-reaching effect have been made in recent years in the distribution of products from farms to markets. An outstanding change is the increasing use of the motortruck. It is estimated that 40 to 50 percent of all shipments of fruits and vegetables and an increasing proportion of the marketings of livestock, grain, hay, feed, poultry, eggs, milk, and many other products now move in motortrucks. Ways are being sought to report these motortruck movements as is done in the case of rail transportation.

In early days all farm crops were hauled to market in wagons and the livestock driven in on foot. But with the coming of the railroads and the building of railroad terminals many of the old city farmers' markets fell into disuse. Each railroad built its own terminal in the cities in competition for the increasing business. Now the scene once more has changed with the coming of motor transport with the result that terminal facilities for handling fruits, vegetables, and other farm products in many large markets have become obsolete. Improperly regulated, uncoordinated with one another, and inefficiently operated, they are an economic waste.

Marketing facilities and market conditions in 40 cities are being studied with a view to recommending ways to remedy this situation. During the year, for instance, a study and report were made in cooperation with the State agricultural colleges of New Jersey and Pennsylvania of the Philadelphia wholesale and jobbing markets for fruits and vegetables, in which the establishment of a consolidated terminal was one of the principal recommendations. The Bureau hopes to release soon a report discussing several problems which seem to be common to a large number of terminal markets. Some information has been gathered also on farmers' markets and so-called regional markets for the handling of motortruck receipts for use in studying the whole problem of farm-to-market distribution.

Two studies are under way dealing with economic problems in connection with the large-scale processing and distributing of farm products. One, in cooperation with the New Jersey State College of Agriculture, deals with the growth of the chain-store systems and its effect upon the marketing of fruits and vegetables in the northeastern cities; the other, in cooperation with the University of Wisconsin, deals with corporate developments in the manufacture and distribution of dairy products and the effect of these developments upon dairymen in Wisconsin and surrounding States.

MASS MERCHANDISING

One of the chief purposes of the chain-store study is to help farmers in the Northeast formulate a marketing program in a situation where more than 25 percent (and the proportion is increasing) of their market fruits and vegetables is being bought and distributed by the chains. As this proportion increases, a steadily decreasing volume will go through the regular wholesale markets, a situation which may seriously affect the bargaining power of the producers.

In Wisconsin and surrounding States, during the past 15 years, large corporations—meat packers, chain-store systems, and dairy corporations—have entered extensively into the manufacturing of dairy products. Small creameries and cheese factories are being replaced by large plants owned and operated by corporations which are factors also in the terminal handling of manufactured dairy products and in the distribution of fluid milk.

In New England, in cooperation with the New England agricultural experiment stations, the New England State departments of agriculture, and Harvard and Clark Universities, a series of studies also is being made of the marketing

of dairy products, such as the trucking of milk and the operation of local milksheds. Sanitary milk regulations have been analyzed, and a report will be issued soon summarizing these regulations in all cities and towns in New England. A collateral project is an effort to coordinate research in milk marketing by the several experiment stations and other research agencies in this region.

RESTRICTIVE STATE LEGISLATION

A factor of increasing importance in the distribution and sale of farm products the country over is the growing volume of State legislation which restricts the interstate movement of these commodities. In many cases inspection laws have been enacted as public health measures, but in others the objective seems to be to expand home industries by means of thinly disguised trade restrictions on farm products from other States. These laws are being studied by Bureau economists with a view to working out a program of Federal, State, and municipal legislation and regulation that will facilitate rather than hamper free trade among the States and adequately protect consumers' interests.

Progress can be reported in the Bureau's studies of farm-to-market costs of distribution. A report has been issued summarizing price spreads for 58 of the more important foods, the data are being kept monthly up to date, and annual statistical supplements will be issued. This research reveals a marked increase in the farmer's share of the consumer's food dollar since 1932, but the amount is still much less than that obtained during the decade from 1920 to 1929.

MARKET NEWS IMPROVEMENTS

The Bureau during the year began a critical analysis and appraisal of its farm-products market news service. This service—a vast news network covering farm-market conditions in nearly 100 producing regions and consuming centers the country over—has been in existence for more than 20 years. Daily, weekly, and monthly reports on practically every farm commodity are issued from 48 cities. They are published by the daily and farm press, broadcast from more than 100 radio stations which donate the radio time as part of their educational programs, and are received by several hundred thousand farmers and farmers' organizations by mail direct.

The objective is constantly to improve this market news service so that farmers may be kept informed up to the minute on market conditions and prices. The Bureau is studying the needs of farmers and dealers for market news and endeavoring to satisfy these needs. Reports are being tested for maximum accuracy and new ways being sought to get these reports economically into the hands of more farmers.

The market news service during the year covered 27 public livestock markets which handle the bulk of the cattle, hogs, sheep, and lambs sold through central markets. It covered the wholesale meat markets at Boston, Chicago, New York, Philadelphia, and San Francisco, and the Boston wool market. It reported from Des Moines the direct marketing of hogs covering trade at 10 packing plants and 22 concentration yards in interior Iowa and southern Minnesota, and covered direct and contract sales of sheep and lambs in Western States through offices at Casper, Wyo., Ogden, Utah, and San Francisco, Calif.

The service on fruits and vegetables covered more than 50 products at 22 markets from Atlanta, Ga., to Seattle, Wash. It issued reports in addition from more than 44 temporary field stations in important producing districts. Financial assistance from 24 States made it possible this year to mail fruit and vegetable news reports to more than 100,000 persons. More daily and weekly bulletins were issued than ever before.

In addition to its regular reports on dairy and poultry products, the Bureau issued a new weekly report on the receipts of eggs at egg auctions and producers' assembling plants in the Northeastern States, and incorporated more detailed data in its monthly hatchery report. The hatchery report now carries information as to the sexing of baby chicks by commercial hatcheries, a recent practice which makes it possible for hatchery men to guarantee the sex of chicks sold as "sexed chicks."

Spot cotton markets were reported each day, and weekly cotton market reviews issued at Atlanta, Dallas, Memphis, and Washington. A weekly report was released covering prices of cotton linters at mill points. Weekly reports of the grade and staple of cotton ginned were issued at key points in the Cotton Belt, and various other monthly and seasonal cotton reports released.

There was a marked increase in the news service covering grain, hay, and feed in response to requests for information on supplies and prices of grain and feeds as affected by the 1936 drought. Special drought news bulletins were prepared for issuance at Kansas City, and many reports issued also in response to requests for information as to supplies and prices of seeds.

A number of other innovations were made in the news service covering all commodities in response to the drought emergency demands for daily and weekly market reports. Besides the commodities already cited reports in regular service were issued on peanuts, honey, and tobacco, and on the quantities of products in cold storage.

Only the high lights of the market news service can be here described; its scope in detail, showing kinds of reports issued, and where and when they are obtainable, is covered in a 60-page mimeographed booklet which is available for persons interested in the markets.

COTTON-PRICE STUDIES

Bureau studies covering a number of years reveal that the prices received by cotton producers in many local cotton markets reflect only a small proportion of central-market premiums and discounts for grade and staple length. This situation doubtless results in the production of larger proportions of the lower grades and staples than if prices to growers reflected a larger proportion of the grade and staple premiums and discounts quoted in the central markets; it tends also to lower the competitive position of American cotton growers.

One of the principal factors responsible for the relatively small premiums and discounts for quality reflected in prices to growers is a lack of adequate information on the classification and commercial value of the cotton at the time it is sold by growers. With a view to improving the price-quality relationships in farmers' local markets, the Bureau is developing plans for establishing and maintaining a practical and dependable cotton-classification service to growers in one-variety communities, and for supplying farmers with adequate information on cotton prices for use in selling cotton. It is believed that a service of this sort would increase the bargaining power of farmers who produce the higher quality cotton, encourage quality improvement, and tend to strengthen the competitive position of American cotton growers.

Studies of the relation of spot cotton prices to prices of futures contracts have indicated that futures trading generally tends to lessen the seasonal changes in prices of cotton as well as changes from one season to another, but that futures trading no doubt increases the frequency of changes in cotton prices and may at times augment these changes. As to the protection afforded by futures trading it is believed that this facility sometimes makes possible a reduction in the cost of merchandising cotton by supplying a means for obtaining protection from changes in prices of spot cotton, and for making savings in interest charges in capital requirements.

COTTON-MARKETING RESEARCH

A South-wide study of cotton marketing is under way, designed to obtain comprehensive quantitative data regarding the channels through which growers market cotton, their knowledge of the quality and market value of their product, the buying and selling practices of first buyers, the market outlets for first buyers, and the attitude of growers and marketing agencies toward possible changes which would improve the functioning of the marketing system.

Preliminary results of this study, covering 101 widely distributed markets, indicate that cotton growers and first buyers generally are not "quality conscious"; that there is an apathy on the part of many growers and a disinclination by many marketing agencies to cooperate in making needed adjustments in marketing; that improvements in marketing procedures are likely to evolve slowly, depending largely upon technological improvements in auxiliary services which may be provided by governmental agencies.

A special study dealing with cotton ginning and wrapping costs shows that rates to growers have increased gradually since 1931 when they averaged $4.12 per 500-pound gross-weight bale to $5.04 per bale during 1934 and 1935. Details showing a wide range in rates charged by individual gins have been published under the title "Rates for Ginning and Wrapping American Cotton, and Related Data, Seasons 1928–29 to 1935–36."

MANY COTTON PROJECTS

Bureau work on cotton includes administration of the Cotton Futures and Cotton Standards Acts, the issuance of cotton-quality reports, the preparation of cotton grades and standards, studies of the physical properties of cotton fibers, cotton-spinning tests, projects designed to improve cotton-ginning technique, economic studies of cotton prices, studies of methods and costs in marketing cotton, and the development of new industrial uses for cotton.

A list of the cotton projects fills more than 25 closely typewritten pages. Only some of the high lights can be covered here. They include studies of the universal standards for the grade of American upland cotton, the publication of detailed information concerning the volume of cotton futures trading in the United States, and the classification and certification of more than 160,000 bales of cotton, under the Cotton Futures Act, as compared with less than 60,000 bales during the preceding fiscal year. More than 648,000 bales were classified under the Cotton Standards Act, compared with less than 98,000 in 1936, much of the increase being at the request of the Commodity Credit Corporation for use in settling loan accounts with growers.

The standard grades for American cotton linters now are extensively used by the cottonseed-crushing mills, especially in meeting the grade requirements of the rayon industry. During the year more than 300 cotton classifiers were licensed under the Cotton Standards Act. They classified more than 4,000,000 bales of cotton.

On April 13 the Grade and Staple Estimates Act was amended by Congress to make possible the classifying of cotton for cooperating producer groups. The amendment provided also for the issuance of timely cotton-market information. But the legislation carried no appropriation for the work, and the service could not be put into effect this year.

Studies which are highly technical but which are of basic importance to all growers and users of cotton deal with the physical properties of the fibers, their spinning quality, and the development of instruments and methods for making such precision determinations. Much of this work deals also with the discovery of physical ways to grade and class cotton and thereby to minimize the possibility of human error. To conduct this exacting research on a properly scientific basis a new cotton laboratory was made available to the Bureau.

Tests have revealed that cotton deteriorates in color—an important grade factor—when it is exposed in the field to weather damage. Reports of the results of these tests have been made available to agricultural extension agencies. Now the Bureau's technologists are trying to learn whether baled cotton in storage undergoes color changes. For this purpose, measured samples are in test storage in offices and warehouses in 14 places, from New Bedford, Mass., to San Pedro, Calif.

Cotton-ginning investigations, in cooperation with the Bureau of Agricultural Engineering, have resulted in the adoption of improved designs of gin-saw teeth by ginning machinery manufacturers, the installation of cotton-drying systems by ginners, and the issuance of recommendations as to cotton harvesting, conditioning, and handling methods best conducive to efficient and economical ginning and the production of high-quality ginned lint.

COTTON-QUALITY PROPERTIES

Investigations of the relation of certain seed-cotton properties to ginning have revealed that cotton with large seeds requires more time and energy to gin than cotton having small seeds; that cotton with heavily fuzzed seeds also requires more time and energy to gin than cotton with less fuzzy seeds; that the greater the amount of lint per given weight of seed cotton, the more time is consumed in ginning, but that the percentage of lint appears to have no effect upon the amount of energy consumed.

Spinning tests of cotton harvested with a new mechanical cotton picker which was extensively publicized last year have revealed that even with the use of full batteries of gin cleaners and extractors the machine-picked cotton was of appreciably lower grade and yielded much more manufacturing waste than hand-picked cotton from the same field and similarly treated. Cotton harvested early in the season by machine was more wasty, because of the green leaf picked with it, than cotton gathered later when the leaves had dried.

COTTON-BALE IDENTIFICATION

Bureau technologists have developed a method for preserving the identity of a bale of cotton from the gin through the various marketing channels to the spinner. It consists of a simple metal tag which cannot be removed until the bale is opened since it is held in place by a wire imbedded in the cotton. Each tag would be inscribed with the name and address of the ginner. The Bureau believes that in addition to other obvious advantages, the use of this tag would tend to facilitate the sale of cotton on description and reduce the waste in marketing incident to the duplication of samplying, classing, and weighing services.

NEW USES FOR COTTON

The principal new cotton product developed by the Bureau during the year is a bag in which Cuban raw sugar may be shipped. Similar cotton bags for Hawaiian raw sugar are being used in experimental shipments. Specifications were developed for a number of cotton fabrics, such as a cotton bagging which will withstand high-density compression without the necessity for "patching" the baled cotton, a shade cloth for nursery stock, a fabric for soil fixation, a gas-tight fabric for use in the fumigation of tobacco beds, and a fabric for shading seedbeds.

Studies were made and reports written on the use of cotton and other materials in bags for cement, of cotton in combed marquisettes, in automobile tires, in bags for flour, and in bags for sugar.

GRAIN STANDARDS AMENDED

The official grain standards were amended during the year in order principally to provide grades for mixtures of flint and dent corn, maximum limitations for shrunken and/or broken kernels in the important commercial grades for wheat, and a new classification for mixtures of durum and other wheats entitled "amber mixed durum."

At the close of the year there were 388 licensed grain inspectors, inspection was available at 176 points in 32 States, and there were 45 Federal grain supervision offices at the important grain markets. Administrative field headquarters offices were maintained at Chicago, Ill., and Portland, Oreg.

Inspection of 1,002,797 carloads of grain in railway cars, cargo vessels, elevator bins, trucks, and sacked lots was made by licensed grain inspectors as compared with 1,079 811 carloads for the year 1936 and 1,079,433 carloads for the 5-year average 1932 to 1936, inclusive. A total of 30,939 "sample inspections" was made during the year by all licensed inspectors at all inspection points in the United States, 24,475 of which were made by the licensed inspectors in the Pacific Coast States principally at country points and primarily for the use of grain producers.

Federal grain supervisors handled 33,354 appeals from original inspections during the year as compared with 49,416 for the year 1936 and as compared with a 5-year average of 46,067. The appeals handled during the year represented 3.3 percent of the original inspections as compared with a 5-year average of 4.4 percent.

The Chicago and Portland Boards of Grain Supervisors handled 1,084 appeals from the grades assigned by district supervisors as compared with 983 such appeals for the year 1936. Board appeals represented 3.2 percent of the appeal inspections made by district supervisors as compared with 2 percent for the year 1936. The two boards received and reviewed 43,790 official supervision and appeal samples from the 45 field supervision offices during the year for the purpose of standardizing the interpretation and application of the standards by district supervisors and licensed inspectors.

COOPERATIVE RICE INSPECTION

Federal-State permissive rice-inspection service supervised by the Bureau was conducted during the year under agreements with the States of Arkansas, California, Louisiana, and Texas. Federal rice inspection was conducted at New Orleans. Four rice-inspection laboratories were operated in the Southern States and three laboratories in California. In addition officially authorized sampling service was available in the Southern States of all important rice-milling and marketing centers.

The total number of inspections of milled, brown, and rough rice during the year was 4,678, and the total quantity of the rice inspected was 1,743,980 hundredweights. Of this total quantity of rice inspected, 1,711,178 hundredweights were milled rice, 17,232 hundredweights were brown rice, and 15,570 hundredweights were rough rice.

In the Southern States the year marked a noticeable increase in the applications for inspection of milled rice moving in domestic commerce. In the California rice area an unusual and important special service was rendered in the inspection of 276,000 hundredweights of milled rice, the supervision of its granulation, and the final inspection of commercial lots of such rice as brewers' rice.

GRAIN RESEARCH

Grain standards research pertained principally to (1) the formulation of grade specifications for mixtures of flint and dent corn and for mixtures of durum wheat and other wheats, and of grade limitations on shrunken and/or broken kernels in the wheat standards; (2) flaxseed dockage and its determination; and (3) methods and sieves for determining the factor "cracked corn and foreign material" in the grading of corn. Studies were continued of the malting properties of barley and of grade factors and specifications to indicate such properties.

Studies were made of newly designed electric moisture meters to determine their usefulness and efficiency for grain-inspection purposes, and recommendations were made for needed changes and improvements in the devices. Studies were concluded successfully of a battery eliminator to attach to electric moisture meters in order to utilize commercial electric current for operating the resistance indicator of the meters in lieu of battery-generated current, thus to eliminate occasional inaccurate tests resulting from weak batteries. Attachments were perfected, and methods of operation and conversion charts were formulated for use in operating electric moisture meters with samples of extremely cold grain for the purpose of improving the accuracy and uniformity of the tests. A revised and complete handbook of instructions for the operation of the electric moisture meter now in use by the Bureau was prepared and released to all operators of the meter.

A research project was inaugurated to study methods and apparatus for promptly testing grain to indicate its soundness or unsoundness for commercial utilization. Definite progress was made in attaining the ultimate and long-desired objective of a definite and practical test to measure the soundness of grain.

Improvements in the Federal dockage tester were made in the form of an automatic feed hopper, standardized resilience in the rubber bumpers, and in the suspension of the lower sieve carriage, all for the purpose of standardizing the action of the device to effect further improvements in the accuracy and uniformity of mechanical determinations of dockage, cracked corn, and foreign material, and other sieving tests.

Bureau employees gave assistance to the Federal Surplus Commodities Corporation and to the Farm Credit Administration in the selection, purchasing, cleaning, and storing of approximately 3½ million bushels of wheat, oats, barley, and flaxseed for emergency seed purposes in Middle Western States stricken by drought and rust during recent years.

Bureau employees were given emergency responsibilities in the administration of the Federal Seed Act in cooperation with the Bureau of Plant Industry. These responsibilities included the checking of import records and the weighing and staining of 200 large commercial lots comprising approximately 17,000,000 pounds of red clover and alfalfa seed imported to meet the emergency demand for such seed caused by restricted domestic seed production during recent years.

HAY, FEED, AND SEED

A number of projects were initiated looking toward the improvement of existing hay, bean, and soybean standards, the promulgation of standards for additional products in this group, and toward improvement of the Bureau's inspection services covering these commodities. Inspections covered more than 104,640 tons of hay, more than 2,350,000 bags of dry beans, more than 40,000,000 pounds of split peas under tentative standards in use for the first time.

A total of 21,425,000 bushels of soybeans were inspected, which represents 72 percent of the total production in 1936 as compared with 66 percent of the total production inspected in 1935. Inspections were made of 1,476,000 bushels of peas, which were 48 percent of the 1936 crop. This percentage was slightly larger than for 1935. Approximately 52,100,000 pounds of alfalfa seed and 8,700,000 pounds of red clover seed were verified during the year. The verification of a smaller quantity of red clover seed than in the fiscal year 1936 was due to the very short crop produced.

Bean dockage inspection as a part of the regular bean-inspection service was inaugurated in Wyoming, Idaho, and Washington, and more than 26,000 bags (principally seed garden beans) were certified. Eighty-six dealers were enrolled in the seed-verification service, and new regulations drafted to strengthen the service this year.

Standardization research included studies to determine the relationship of oil and protein content to the quality of soybeans; an amendment to the standards for beans was proposed to permit greater flexibility in the type of sieve used and to allow inspectors to consider the principal use of the various types of beans when inspecting for dockage and defects, and several refinements were incorporated in the standards for dry peas. Minor changes in the tentative standards for split peas were accepted by dealers and manufacturers, and it is proposed to promulgate the standards officially this year.

Research designed to improve the standards for hay included studies of the chemical composition of the leaf blades, leaf sheaths, heads, and stems of the timothy plant and the leafiness of clover. Over 100 sets of type samples to illustrate the Federal hay standards were prepared and furnished to State colleges and other institutions for educational work, and many samples were graded for various Government departments and State institutions which are carrying on experimental work for the purpose of determining the feeding value of various kinds of hay. Training schools for veterinary officers of the United States Army and for veterinary technicians were held in Washington. Two manuscripts were prepared for farmers' bulletins—one on high-grade alfalfa and the other on high-grade timothy and clover hay.

Samples of thresher-run timothy and Sudan grass seed were analyzed in connection with the development of uniform methods of determining dockage. Ways to use hand screens or small cleaning machines in removing impurities from thresher-run seed were studied. A study was made of the relative feed value of different feeds based on digestible protein and carbohydrates equivalent at given values for the principal protein and carbohydrate feeds, and a new and more comprehensive price index was constructed covering seasonal variations in feedstuff prices.

There was a marked increase in the news service covering grain, hay, and feed in response to requests for information on supplies and prices of grain and feeds as affected by the 1936 drought. Special drought news bulletins were prepared for issuance at Kansas City, and many reports issued also in response to requests for information as to supplies and prices of seeds.

LIVESTOCK-MARKETING RESEARCH

Economic research dealing with livestock and meats included studies of livestock auction markets, of relationships between livestock and meat prices, of shifts and trends in livestock production and slaughter, and of direct marketing. A survey revealed there are more than 1,200 livestock auction markets the country over. About 900 are in the Corn Belt States. Iowa has about 200.

A study was made in cooperation with the Iowa Agricultural Experiment Station and the Farm Credit Administration of the development of growth of the livestock auctions in Iowa, the status of these auctions as to physical facilities and financial set-up, and the service being rendered to livestock producers. Results of this study are being summarized for publication.

A reconnaissance survey was made of the livestock market situation and market facilities in the South in view of the recent expansion in livestock production there, an increase which has caused some of the larger slaughtering concerns to expand their southern facilities. There also has been an increase in the number of livestock auction markets, and a greater interest by producers in the sale of livestock on a grade basis.

Studies of regional shifts in livestock slaughter revealed significant changes in the last 15 years as a result of shifts in production and an increasing tendency among slaughterers to expand operations in producing areas. There

have been marked increases in slaughter in the northwestern Corn Belt and in the Southern and Mountain States. Slaughter has decreased in the Northeastern States and in the eastern and southwestern Corn Belt.

Surveys revealed that in 1936 about 20 percent of the cattle, 30 percent of the calves, 48 percent of the hogs, and 28 percent of the sheep and lambs slaughtered by wholesale operators were bought direct by packers. This method of buying has increased enormously since the World War, but its greatest expansion has been in the northwestern Corn Belt. It consists essentially of the buying of livestock at country points instead of at public stockyards.

Studies of the relationships between retail and wholesale prices of meats and between meat prices and livestock prices are important research projects. Wholesale and retail beef prices are analyzed in their relationship to cattle prices, and determinations made of byproduct values. These studies reveal marked fluctuations in the spread between live-steer values and product values.

In studying the relationships of hog prices to prices of hog products, ways to estimate approximate yields of different products from hogs of different weights, grades, and dressing yields have been developed and are being checked with data obtained from actual slaughter tests.

The Bureau issued a preliminary report presenting part of the results of studies on the relationship of hog prices to wholesale prices of hog products over a period of 32 years. A more complete report showing seasonal and long-time changes in the relationship of product prices to hog prices is to be published.

MEAT OUTPUT DECLINES

Bureau studies revealed that the per capita production of all meats from slaughter was at its highest level during the period from 1899 to 1903, the latter year marking the peak. Output then dropped sharply until 1914, it increased somewhat during the World War period, but fell off in 1920 and 1921. Increases after 1921 were followed by further reductions until 1930.

The output of meats held near the 1930 level until 1935 when there was a sharp decline as a result of the 1934 drought. Per capita production in 1935 was 36 percent less than in 1908, and 34 percent less than the 10-year average 1900–1909. Decreases in exports and increases in imports during the 36-year period caused less extreme changes in per capita consumption than in production, but over this long period per capita consumption has declined because domestic production has not kept pace with the increase in population.

GRADES FOR LIVESTOCK

Research in the standardization and grading of livestock was intensified and expanded to facilitate more accurate comparisons between livestock prices, wholesale dressed-meat prices, and retail meat prices. Plans were drawn for a study of the extent to which livestock prices as quoted by class and grade correlate with dressed-meat prices as quoted by corresponding class and grade.

Standards for stocker and feeder cattle and calves and for slaughter, stocker, and feeder sheep and lambs were prepared; standards for "specialty" meats and meat products are in process of preparation. More than 547,000,000 pounds of meat and meat products were graded at the request of packers, wholesalers, buyers, and others, compared with less than 424,000,000 pounds the preceding year.

Many lamb-grading demonstrations were given in Virginia, West Virginia, and North Carolina to familiarize public and private agencies with the tentative standards for market classes and grades of lambs. Cattle-grading demonstrations were given in the eastern Central States for the same purpose in connection with the Government grades for cattle. In cooperation with the Extension Service in 8 Western States, 40 livestock-grading demonstrations and marketing meetings were held.

A cooperative agreement was signed with the Virginia Agricultural Experiment Station, the Virginia State Division of Markets, and the United States Bureau of Animal Industry to study the differences between cattle and beef finished on Virginia pastures and those finished on standard grain rations. This research is expected to yield information for use in planning soil conservation and land utilization policies for the southern Appalachian region.

WOOL RESEARCH

Research on wool included the preparation, in cooperation with research organizations in the wool industry, of specifications for grades of wool tops, based upon diameters of fibers and extent of dispersion. The practicability of commercial use of these specifications is being studied. In fiber research much data dealing with the fiber measurements with respect to the different grades of wool top were obtained.

An extensive program of research dealing with wool shrinkage and wool values, the program being actively supported by leading wool-growers' organizations, was initiated in cooperation with experiment stations in two States. The objective is to develop ways to determine the value of wool clips through the testing of representative samples. Wool-marketing research dealt with auction sales methods newly introduced into the United States.

NEW DAIRY AND POULTRY RESEARCH

Many research projects were conducted in connection with dairy and poultry products, in addition to the improvements noted elsewhere in this report in the market news service on these commodities. They dealt with subjects such as the ratio of butter prices to wholesale prices of basic commodities, the relationship between per capita production and consumption of butter, costs of manufacture and distribution of butter and cheese, the production of skim-milk and buttermilk products, foreign trade of the United States in manufactured dairy products, changes in seasonal variations of butter prices and market receipts of butter, numbers of milk cows on farms, the production and consumption of condensed and evaporated milk, trends in prices of butter-fat in relation to feed grains and meat animals and other agricultural products, and the production and consumption per capita of fluid milk and manufactured dairy products.

Other projects included an economic survey of the live-poultry industry in New York, N. Y., revision of the handbook of poultry and egg statistics, and of a handbook of dairy statistics, preparation of a report of a survey covering the consumption of eggs in New York, and much research and service work in connection with the standards and grades for dairy and poultry products and their increasingly widespread commercial use.

Grading and inspection work was expanded through increased commercial grading in terminal markets and the extension of grading services at country points, particularly on butter concentrated at large shipping points where it is purchased from cooperative and independent creameries on a grade basis, and the Government-graded butter is packaged with certificates of quality for retail distribution.

The egg-grading service was extended to several places in Michigan and North Carolina, and at additional places in other States where this work was already under way. There was a further expansion in the use of certificates of quality and seals in the merchandising of Government-graded butter and eggs. Another development was the installation of keeping-quality tests of Government-graded butter at certain concentration points. A series of nine public conferences was held in various cities in connection with proposed revisions of the standards of quality for creamery butter.

FRUITS AND VEGETABLES

The buying and selling of fresh fruits and vegetables on the basis of standard grades worked out by this Bureau has become established trade practice. The grades are used also by the Agricultural Adjustment Administration in its marketing agreements with producers and shippers, and by the Federal Surplus Commodities Corporation in its purchases of food products for relief distribution. Continuing research seeks to improve the standards, which now cover 53 different fresh fruits and vegetables. During the year a number of the standards were revised, and investigations started on standards for additional products.

The Bureau maintains an inspection service at produce-shipping points the country over, where persons using the standard grades may have the quality of their products certified by the Government. Similar service is available in consuming markets. More than 400,000 cars of fruits and vegetables were

so inspected during the year. Many shippers who do not have certified inspection also use the standard grades—a much desired practice, provided the grading is properly done. For the purpose of handling situations where the quality of products is other than that indicated by the markings on packages, the Secretary of Agriculture last January designated the Bureau's inspectors as inspectors under the Food and Drugs Act.

In most misbranding cases which have come to the Bureau's attention a simple warning has been enough to induce the removal of the incorrect grade markings; but in 15 cases seizures were made by the Food and Drug Administration upon the Bureau's recommendation, and correction of the mislabeling required as a condition of release of the products from Federal custody. More than 160 cases of misbranding as to grade or weight were handled between January and the end of the fiscal year.

The Bureau's grades for canned fruits and vegetables also are being increasingly used by the trade, not only as a basis for trading but in recognition of the growing consumer demand for grade labeling of canned foods. Many public institutions are using the grade specifications in the purchase of canned fruits and vegetables, as they do also in the buying of meats and the many other foods for which the Bureau has developed standard quality grades.

Since methods of food distribution are rapidly changing, especially in the marketing of fresh fruits and vegetables, the Bureau is receiving many requests for official information dealing with methods of grading, packing, and selling farm produce. Ways to eliminate needless and inefficient marketing practices are being sought. Data on prices paid for various varieties, grades, and sizes of fruits and vegetables in the markets are wanted by growers and shippers organizing marketing programs. Information is wanted on transportation and marketing charges, and as to the relation of supplies and prices of products.

More than 2,400 complaints of violations of the Perishable Agricultural Commodities Act were received during the year. This was a 10-percent increase over 1936, but through the Bureau's efforts amicable settlements were obtained in about 90 percent of the cases. Formal action under the act, which prohibits unfair and fraudulent practices in the marketing of fresh fruits and vegetables, were taken relative to the remainder of the cases. Upon recommendation by the Bureau, the Secretary of Agriculture issued 209 reparation orders. The licenses of 12 commission merchants were automatically suspended for failure to pay reparation awards, 6 licenses were ordered revoked for other violations of the act, and 9 ordered suspended.

At the close of the year, 18,077 produce dealers, commission merchants, and brokers held licenses under the act, an increase of 1,424 as compared with 1936. During the 7 years the law has been in effect, more than $1,000,000 in license fees, or considerably more than the amount of the Federal appropriations for the administration of the Perishable Agricultural Commodities Act, has been deposited in the United States Treasury.

In connection with the administration of the Standard Containers Act the Bureau investigated the growing use of second-hand baskets in the produce industry. It was found that with certain exceptions the sizes of these baskets complied with the provisions of the law, but that in some instances their use may violate State and Federal sanitary regulations or, unless properly relabeled, the misbranding provisions of the Food and Drugs Act.

TOBACCO INSPECTION

The Tobacco Inspection Act provides, in brief, that upon favorable referenda by tobacco growers the Secretary of Agriculture may designate auction markets for free and mandatory inspection service, coupled with market news service. Under its terms 23 auction markets have been designated, and the service was in operation on all but 3 of these during the year (an injunction halted the service on 3 markets). On the remaining 20 markets, a total of 146,113,980 pounds of tobacco was officially inspected by the Bureau during the marketing season. Other tobacco inspections raised the total for the year to 152,607,344 pounds; present indications are that much more will be inspected during the fiscal year 1938.

An important service being furnished to growers in connection with inspection and market news is the demonstration of proper methods of sorting tobacco and preparing it for market. The objective is to reduce the large

volume of tobacco that goes to market each year so poorly handled as to be a source of loss of revenue to growers. In carrying out the demonstrations Bureau representatives furnished instruction directly or indirectly through agricultural teachers and others to 36,732 tobacco growers. To make the work more effective 22,000 pieces of literature were distributed bearing upon elements of grade in tobacco, instructions in tobacco sorting methods, and illustrative reports.

WAREHOUSE ACT ADMINISTRATION

At the end of the year, about 836 warehousemen who store cotton, grain, wool, tobacco, canned foods, and other agricultural commodities held licenses issued by the Bureau under the provisions of the United States Warehouse Act. Administration of this act involves investigations to determine whether licensees are complying with the rules and regulations under the act, and whether new applicants can meet the standards prescribed for licensing.

Collateral research deals with ways to improve the administration of the Warehouse Act and to make it of maximum value to farmers, warehousemen, and public and private lending agencies. A major achievement in the interest of warehousemen and depositors during the year was the securing of a reduction in premium rates charged for the bonding of Government-licensed warehousemen. The rate was lowered from $10 per $1,000 of principal to $10 per $1,000 for the first $10,000 of principal, $5 per $1,000 for the next $15,000, and $3 per $1,000 above $25,000.

Another achievement was the securing from the Arkansas Insurance Rating Bureau of a credit of 10 percent in insurance rates on all products stored in Government-licensed warehouses operating in Arkansas and an equal credit in insurance rates on the warehouses and their equipment. These credits were granted because of the stringent regulations which must be observed by Government-licensed warehousemen, and the supervision exercised by the Bureau. Heretofore the credit applied only to cotton warehouses.

Following extensive investigations, a ruling was made last year permitting the mixing of different grades of grain in licensed elevators, provided the varying grades belong to the same depositor. Regulations applicable to licensed warehousemen operating in terminal and futures contract markets were issued.

INFORMATION

In the last 15 years there has been a great outpouring of agricultural statistics, reports, bulletins, and other economic publications by Federal and State agencies. There has been mass production of facts and figures upon a great variety of subjects relating to agricultural economy. This raw material, unquestionably useful to economists studying and analyzing agricultural adjustments, unless interpreted, frequently tends to confuse, not enlighten, farmers.

There is obvious need for an increase in quality production of agricultural economic information. There is need to refine the raw material assembled by research workers, select the most essential facts and conclusions, and concentrate on their dissemination. This objective is now being sought by the Bureau.

Farmers at all times want the essential facts regarding current and prospective farm products, supply, demand, and price situations. In an effort to meet this requirement the Bureau has discontinued its monthly "prospect" reports which carried much unrelated data, and is issuing instead a series of monthly agricultural situation and outlook summaries covering 15 principal farm commodities or groups of commodities.

These situation reports present the salient facts gathered by the Bureau's research workers and analysts. They summarize the current and prospective situation as to supply, demand, and price, and seek to guide farmers intelligently in their production and marketing operations. These reports have been favorably received by farmers, their contents are widely published by the press, and the State extension services use much of the material in State and local informational work.

Other Bureau publications have been recast for more effective presentation and use by farmers of the results of the Bureau's economic and statistical research. Instead of a publication containing uninterpreted tables of statistics, crop and price reporters now receive a special edition of the Bureau's monthly publication The Agricultural Situation—eight pages of condensed commodity reviews.

The publication Crops and Markets, a statistical repository, has been reduced in size and circulation in the interest of economy. The full edition of The Agricultural Situation has been remodeled so that instead of containing largely market reviews and statistics it summarizes all the available facts on supply and demand in brief commodity reviews, and publishes in addition short, timely articles by Department economists presenting the main facts and conclusions of economic research and discussing new developments and policies in agriculture.

Studies have been made and plans formulated for more effective presentation of the salient facts in agriculture by radio, press, graphics, exhibits, and motion pictures. These media have long been used by the Bureau but methods of using them have lagged behind the constantly changing techniques in oral and visual education.

The Bureau is a living encyclopedia of economic information—information for the research worker, the student, and the administrator, as well as for farmers who desire to be informed on the interplay of the economic forces which affect their business. Besides making this information available in formalized mediums, the Bureau is tending increasingly to encourage in the field of the Department's work an increase in informal contact relationships.

This has substantially increased the usefulness of the Bureau's work among policy-making organizations and officials, particularly in cooperation with the Agricultural Adjustment Administration, the Farm Security Administration, and other agencies developing new programs.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - - Price 5 cents

REPORT OF THE CHIEF OF THE BUREAU OF AGRICULTURAL ENGINEERING, 1937

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF AGRICULTURAL ENGINEERING,
Washington, D. C., October 9, 1937.

Hon. HENRY A. WALLACE,
Secretary of Agriculture.

DEAR MR. SECRETARY: I submit herewith the report of the Bureau of Agricultural Engineering for the fiscal year ended June 30, 1937.

Sincerely yours,

S. H. MCCRORY, *Chief.*

CONTENTS

INTRODUCTION

A century has passed since the invention of the steel plow and the grain harvester. Burned drain tile was first made and laid in this country at about the same time. Along with the cotton gin, which appeared nearly 50 years earlier, these aids to agriculture represent the monumental beginnings of a development of engineering factors in farming in the United States that made possible rapid and widespread changes in way of life of a large part of the population. The recent formal celebrations of the centennial of these events found agricultural engineering research on an organized basis, with power farming well developed, and schools of agricultural engineering in practically all of the States. There are now more than 1,250,000 farm tractors in use, electric power is available on 1,000,000 farms, 85,000,000 acres of the best agricultural land are in organized drainage districts, 19,000,000 acres are under irrigation in the

West, and supplemental irrigation is now practiced on nearly 1,000,000 acres in the humid part of the country east of the one-hundredth meridian.

It seems fitting that on passing this significant 100-year mark we make note of these broader aspects of what has happened before discussing more recent research developments in which this rather new Bureau has had a hand.

The country has entered a period of refinement in the development of engineering factors in farming. The tendency now seems to favor the family-size farm, and there is no very noticeable tendency, except in the exclusive wheat regions, for farms to become larger. Conspicuous among recent developments are the general-purpose, small handy tractors, and the small combine grain harvesters now make these power units even more effective on small farms. In addition to the farm jobs, these tractors, many on pneumatic tires, haul products to market at 15 to 25 miles an hour. The small combine represents a much smaller investment than the machines displaced, operates at high speed, and can be used on moderate-sized farms for harvesting small grains, soybeans, and some other crops.

Most farm machines are now lighter per unit capacity than a few years ago. Also, a machine such as the small combine weighs much less than the machines displaced. Estimates by Bureau engineers place the tonnage of farm machinery metal consumption in 1936 at about 2,000,000 tons, the same as estimated in 1917 by the War Industries Board. Farmers, obviously, are getting more out of the metal they consume than they did 20 years ago.

There has been a revival of activity in the improvement of land-drainage systems in the past few years, probably explained in part by the work of the Civilian Conservation Corps drainage camps, under direction of the Bureau, in improving existing public drainage ditches.

In spite of the continuous large consumption of basic materials and rapid increase in the use of new types of equipment, surveys show large numbers of farms are poorly organized and badly equipped, and even those of the better type show defects that could be practically corrected by careful study of the engineering factors.

The recent improvement in farm income resulted in increased buying of farm machinery and drain tile, indicating a readiness to correct the most apparent production weaknesses as soon as feasible. On the other hand, buildings, including farmhouses, are being neglected to such a degree that new construction and repairs do not at present make up for normal depreciation. Possibly part of this neglect of basic equipment may be traceable to the tendency to give first attention to income-producing equipment or to a common practice of buying more land when income is on the upgrade.

The Bureau has been active in the development of many new things of potentially great economic importance on farms, small or large. Some of these developments are listed below and, with others, are discussed in more detail farther along in this report.

SOME OUTSTANDING RESULTS

Supplemental irrigation: Investigations in strawberry-growing sections in North Carolina and Maryland show excellent results from the use of irrigation in periods of low rainfall. Some of the treatments have brought increases in yields of 400 quarts an acre over the best unirrigated test plots and as much as 1,000 quarts over the average of unirrigated beds.

Forecasting irrigation water: Snow-survey reports in the Western States are giving irrigation farmers early-spring information on the supply of water to be expected. In watersheds where actual measurements of the season's water have been made, the forecasts have been proved accurate to a high degree.

Water spreading: Improvements in methods of building up ground-water supplies by delaying run-off and giving time for flood waters to soak into the soil are showing good results in raising the water table where it has fallen very low. A bulletin on the subject has been prepared.

Fertilizer placement: Studies on the exact placement of fertilizer to determine what position with relation to seed and roots produces best yields, have resulted in large increases in yields and in improved distributing machines. For such crops as beans, cotton, peas, potatoes, and tobacco results show yields are best when the fertilizer is placed 2 to 3 inches to the side of the row and not less than 3 inches deep.

Preparation of land for cotton: Cotton grown on Greenville sandy loam in Alabama produced a larger yield and better fiber when less than the usual preparation work was done and the land was left in rougher and more open condition, saving power and labor.

Sugar-beet harvesting: A sugar-beet harvester, developed on lines worked out by Bureau engineers, showed good and economical performance in tests under a variety of conditions.

Vapor spraying: A vapor sprayer, based on the principle of the steam cleaners used on stone buildings, has given good results in control of various insects and diseases attacking peas, potatoes, apples, grapes, and cherries, using only about one-fourth as much spray material as the usual hydraulic sprayers.

Potato storage: Good success has been attained with potato-storage houses for the North designed for condensation of excess moisture on cooled walls. Water is drained away, losses from rotting of potatoes are greatly reduced, and the building itself, being drier, lasts longer.

Building plans for Northeastern States: A book of plans for farmhouses and other farm buildings and service equipment adapted to the Northeastern States was prepared with the assistance of the extension services of the Department and the 12 States concerned.

DIVISION OF FARM STRUCTURES

Recent reports on the condition of farm buildings in many parts of the country are not encouraging. While there are many examples of well-planned, well-maintained buildings, the need for modernization is apparent in most farmhouses, and the poor planning and grouping of farm buildings in general is evident. The buildings on the average farm have been and are still being neglected. Even with much better farm incomes during the past 2 or 3 years, improvements made during 1936 were not enough to make good the depreciation for the year, much less to repair the effects of neglect of previous years. Rising land values raise the suspicion that much of this increased income may go into land speculation as profits did after the World War. The tragic disappointments that followed are now history. In most cases money spent for home and farm improvements would have been safely invested, and would have paid dividends in comfort and better living.

In an effort to raise the standards of farm building, engineers of the Bureau are making efforts to get information and good plans into the hands of rural contractors, mechanics, and lumber dealers, important sources of information for planning and construction for the average farmer. Cooperation with such agencies is essential if standards in rural building are to be improved. The farm building plan book for the Northeastern States, mentioned in the extension section of this report, represents an effective means of furnishing these sources with good plans.

The Bureau, in cooperation with the University of Wisconsin, has undertaken a new type of research based on observations of conditions in houses as they were in use and further observations after remodeling. The intention is to bring out fundamental facts on farmhouse design and construction and their effects on comfort and the welfare of the family. The houses of cooperating farmers are used as laboratories, and a thorough study is made of every feature. The investigators record the time required for housework and the use of the house by each member of the family for work, study, and recreation. Temperatures in each room are measured to learn the average, the daily range, and the variation between floor and ceiling and from the heated to the unheated side. Drafts are traced and measured, and natural and artificial lighting are studied. With this background, the family and the agricultural engineer, the home economist, and the architect, together plan the remodeling. The owner and the builder then carry out the plan. Tradition usually has much to do with the way in which details of these improvements are carried out. Carpenters are commonly reluctant to execute all details as planned. Therefore, on this research project the work is closely supervised to see that the plans agreed upon are followed. After the improvements are completed observations are made on the same factors covered in the preliminary operations, and the value of the improvements is determined by analysis of these factors, and by study of the detailed costs.

The complete study of a house extends over 2 years, to obtain full before-and-after comparisons. Tests are now being conducted in two remodeled houses to check the effects of improvements on comfort and fuel economy. It has already been found that temperatures are more uniform throughout the houses and that cold walls and drafts from air infiltration have been eliminated. Rooms which formerly were unfit for occupancy for many months are now usable throughout the year.

After another winter facts will be available to guide other farmers facing similar problems and to aid rural architects and extension workers. In addition to the usual comfort tests, the engineers are making a thorough analysis of several farmhouses with a view to eliminating as far as possible other features which commonly are a source of annoyance and inconvenience. The results of this study should serve as a basis for better farmhouse plans.

Studies of comfort factors in southern farmhouses are continuing in cooperation with the University of Georgia. In addition to the tests in occupied farmhouses, tests are under way in one large and six small experimental houses, each constructed of different materials. Cost records have been kept and should be of special value, as new methods of construction, which may prove economical and suitable for farmhouses, were used in four of the houses.

BUILDINGS FOR FARM PRODUCTS

Efforts to develop inexpensive but safe storage for crops are being continued. The demand for such facilities is as old as agriculture, but public and official appreciation of the dependence of economic status and change upon technical developments has given new emphasis to the demand. One problem still not completely solved concerns grain storage on the farm. To determine what changes in structures and methods are necessary to insure safe farm storage of wheat, studies were begun in 1936 under the Bankhead-Jones special research fund.

Experimental and field studies are carried on cooperatively by the Bureaus of Agricultural Engineering, Agricultural Economics, and Plant Industry, and the agricultural experiment stations of Illinois, Kansas, Maryland, and North Dakota. Field observations of farm storage are also made in Minnesota, Michigan, and Ohio. The primary objectives are (1) to find what grades of wheat can be safely stored in typical farm bins, and (2) what types of storage structures will best preserve or improve the condition of the grain. Several methods of ventilation are being tested at each station and two types of small portable driers operating on new principles are being developed.

The record from each bin includes (1) the conditions of storage in terms of weather, bin and handling features, and moisture content and grade of wheat placed in the bin; and (2) the changes occurring in moisture content, temperature, rancidity, milling and baking characteristics, damaged kernels, odor, grade of wheat, germination, and insect infestation.

Results that seemed inconsistent on preliminary examination of the records were found possible of explanation when the factors recorded were grouped as follows: (1) External bin environment; (2) bin contents; (3) bin materials and design; (4) handling and treatment; (5) internal bin environment; and (6) germination and spore load. These groups of factors determine the demand or "load" on the storage equipment and the ability of the equipment to meet it. In other words, they identify the foundation upon which the two primary objectives of the investigations can be attained. Work in 1936 was greatly handicapped by drought, much of the wheat having a moisture content of less than 12 percent, which practically eliminated storage difficulties as moisture content of the wheat is the most important single factor determining whether it can be stored. Ventilation of the bins appeared to be the most effective method of protecting slightly damp wheat, but no entirely satisfactory means of supplying adequate ventilation was found. At this writing the 1937 work is not sufficiently advanced to report.

As a result of the investigations on potato storage in cooperation with the Maine Agricultural Experiment Station and the Bureau of Plant Industry, two bulletins, one on farm storages and one on trackside storages, were issued through the Maine Extension Service. A manuscript for a Department technical bulletin covering this work is completed and plans for a trackside storage and a farm storage have been prepared.

Important principles to be observed in building and operating potato storages were found to be proper use of insulating material, protection of the building against damage from condensed moisture, and maintenance of correct temperature and humidity conditions. Much of the trouble encountered in potato storages has resulted from the fact that in most buildings, if the humidity is kept high enough to retard loss in weight of the stored potatoes, the consequent condensation on the structure causes the building to fail after a few seasons' use. The construction and operation practices recommended as a result of these studies will result in less shrinkage loss, elimination of rotting of the building, and less need for attention to ventilation and heating.

In cooperation with the Virginia Agricultural Experiment Station observations and tests were made in two apple-storage houses. It was found that some storage operators are not familiar with some of the well-known principles of cold storage and common storage practices. Keeping quality of apples can be improved by better methods of storing and by taking more advantage of low outside temperatures. The results of these studies will be used in a bulletin.

In cooperation with the Bureau of Dairy Industry measurements were made of the lateral and vertical pressures on walls and on the densities of corn silage at various depths in a 14- by 40-foot silo. The measurements covered a complete season of storage. When the silage was removed there was an increase in the lateral pressure against the walls in the lower section, and a tendency for the silage to lift the walls as the weight above was removed and the compressed silage in the lower part of the silo expanded. With the New Jersey Agricultural Experiment Station a similar study is being made of pressures caused by hay-and-molasses silage. This silage seems to exert a considerably greater pressure than corn silage.

Preliminary studies were made of methods of accurately determining conditions in different parts of corncribs so that later studies dealing with storage of soft corn may be carried out more efficiently. In making such studies it is necessary to measure changes in moisture content as storage proceeds. There has previously been no satisfactory way of determining moisture content of ear corn in cribs since samples cannot be drawn by probing as in the case of small grains. This preliminary work was done in cooperation with the University of Illinois using moveable cribs which can be weighed on a track scale. The accuracy of determinations of moisture loss based on samples removed from the crib at intervals was checked against the total weight loss but the sampling did not prove entirely satisfactory. Indirect determination of moisture by measuring the humidity in various parts of the cribs by use of a powerful aspirating psychrometer and by determining electrical resistance of individual ears or grains appeared promising.

Results of winter tests on cows on a large Wisconsin dairy farm showed that uniform stable temperatures around 45° to 50° F. without drafts kept the animals in better health, and maintained the milk yield at a somewhat higher level than colder or warmer or drafty stables. Four stables of 22 cows each were used. A bulletin covering this investigation is being issued.

USE OF BOTTLED GAS ON FARMS

In cooperation with the Bureau of Home Economics, a comprehensive study of the efficiencies and character of cooking done by cook stoves using kerosene, gasoline, bottled gas, city gas, and electricity has been completed. A manuscript has been prepared for a publication on the use of bottled gas on farms.

A comprehensive study of chimneys and fireplaces, including the so-called patented fireplaces, was begun for the purpose of revising Farmers' Bulletin 1649, Construction of Chimneys and Fireplaces.

PROTECTING PERISHABLE PRODUCTS IN TRANSIT

Technical Bulletin 550, Protection of Apples and Pears in Transit from the Pacific Northwest During the Winter Months, a joint publication with the Bureau of Plant Industry was issued in March 1937. The authors recommend such practices as operating heaters according to temperatures within the car, avoidance of dry insulating material added around the load in such a way as to obstruct air movement, use of latent heat of water to prevent freezing in certain shipments, and elimination of the ventilation service during winter.

Transportation tests with citrus fruit from California indicated that icing cars with one-half the usual quantity of ice provides temperatures and air circulation equivalent to full icing, if the ice is supported in the upper half of the bunkers. Public-service Patent No. 2061941 was issued November 24, 1936, covering the electric anemometer developed for these transportation studies. This type of anemometer is now being used extensively in other phases of the Bureau's work where measurements of convection air currents are necessary.

A second unit of the calorimeter for measuring heat of respiration of fruits and vegetables was completed and Irish Cobbler and Green Mountain potatoes, York Imperial and Stayman Winesap apples, oranges, and strawberries were tested. In general the measured heat of respiration corresponded closely

to that calculated from the production of carbon dioxide. The tests furnish records on heat generated by stored products, information of value to storage house designers and operators and to those studying the physical reactions of plant material to various temperatures.

DIVISION OF DRAINAGE

HYDRAULIC STUDIES

Hydraulic studies, including 600 completed experimental tests on the flow of water in open channels, have been conducted at the Iowa Institute of Hydraulic Research in cooperation with the University of Iowa to develop information useful to designing engineers in utilizing the hydraulic jump on sloping floors for preventing erosive damage to water-control structures. The results will be applicable to the construction of drainage systems, irrigation ditches, overflow dams, spillways, or other structures where it is necessary to dissipate kinetic energy developed in lowering water.

The phenomenon of the hydraulic jump, involving a short length of turbulent flow and a rise in the water surface, transforms a stream of high velocity and shallow depth to one of greater depth and lower velocity which therefore has a lower capacity for erosion of the outflow channel. Hydraulicians have developed the theory of the hydraulic jump on level floors or stream beds, and many structures have been designed to make use of this phenomenon. However, without the aid of heavy baffles or large stilling pools, which would be especially expensive in small structures, control of the jump on level floors has been very uncertain because slight variations in depth and velocity of inflow or in depth of outflow may cause the jump to recede from the spillway for distances so great that protection of these lengths of channel would be expensive. To control the location of the jump, and limit its travel under the fluctuating conditions of flow in natural and artificial drainage courses, use of sloping rather than level spillway aprons seems likely to effect regulation by automatic adjustment of the tail-water depth to the fluctuating conditions of inflow.

The experiments were conducted in a glass-walled flume 26 feet long, 2.5 feet wide, and 3 feet deep with aprons at 6 to 1, 3 to 1, 2 to 1, and 1 to 1 slopes. The maximum length of apron was 10 feet; depth of inflow ranged from 0.06 to 0.20 foot; depth of outflow ranged from the minimum that would obtain a jump in the flume to 2.5 feet; quantities of flow ranged up to 5.5 cubic feet per second. Inflow and outflow were controlled by adjustable gates. Observed data included location of jump, length of the jump and the roller, and distribution of velocities in the flow away from the jump. The results of the experiments are now being analyzed.

RUN-OFF STUDIES

The collection of data on run-off from the Ralston Creek watershed in Johnson County, Iowa, was continued in cooperation with the University of Iowa. A report entitled "A Summary of Hydraulic Data, Ralston Creek Watershed 1924–35" was published as University of Iowa Engineering Bulletin 9. The report presents the basic data obtained during the years 1924 to 1935 without any attempt to analyze the information or present conclusions. The field work during the year, in addition to the regular run-off and rainfall measurements, included a detailed soil survey and land-use study of the watershed. During the fiscal year 1938 it is planned to analyze the data so far collected with the view of developing for the region a rational basis for determining quantities and rates of run-off from small watersheds, expected frequencies of different rates of run-off and the effect of various topographical, land-use, and climatological factors upon run-off.

DURABILITY OF DRAIN TILE

The investigations for determining methods of making drain tile resistant to soil alkalies, soil acids, and frost were continued in cooperation with the University of Minnesota and the Minnesota Department of Conservation.

The concrete-alkali studies during the year had to do principally with the use of linseed oil, soybean oil, and tung oil admixtures. Five-year tests of concrete containing linseed oil indicate the oil increases resistance to soil alkalies

and tests are now being made with nearly 6,000 concrete cylinders in which soybean and tung oils have been used as well as oils of the linseed class.

The concrete-peat work was not extended during the year. Three- and five-year tests have now been completed for 50 types of concrete, and 10-year tests have been made on 30 types. Installations include three peats in Minnesota, three in Wisconsin, and an acid-mineral soil in South Carolina.

In general it is evident that the acids of these soils do much damage to concrete of low quality and relatively little to good or fairly good concrete. Ten-year tests of all 50 types of concrete will be completed in 1937.

Tests were made recently of some 700 concrete silo staves and the laboratory supervised the making of about 1,200 experimental concrete staves. This work is closely related to the concrete-peat studies because the acidity of corn silage is closely comparable to that of the more acid peats. Durability of concrete silo staves very probably is dependent on the same factors that affect the durability of concrete drain tile exposed to the action of highly acid peats.

DRAINAGE OF TIMBERLANDS AND OPEN MARSHES

In cooperation with the Minnesota Department of Conservation and the University of Minnesota, investigations were continued in northern Minnesota to determine the effect of drainage upon the growth of black spruce and tamarack, and to ascertain the extent to which ditches have affected lake levels and stream flow and the water-storage capacity of swamps in timber, in wild marshes, and in hay. Indications are that deep seepage losses in some of these northern marshes are negligible.

DRAINAGE OF SUGARCANE LANDS

The experiments relating to the effect of various depths of drainage on the growth of sugarcane on the alluvial soils of southern Louisiana were continued, but the 1936 climatic conditions were very unfavorable to the growth of cane. Investigations were confined principally to experiments with two cane varieties, C. P. 807 first stubble crop and Co. 290 second stubble crop.

It appears that for crops produced under 1936 climatic conditions the beneficial effects of deep drainage by tile drains are not sufficient to offset the cost of providing the drains. Because sugarcane yield is affected by many such factors as climatic conditions, extent and kind of cultivation, variation in application of fertilizers, fertility and character of soil, uneven stand, insects, diseases, spacing of rows, and the time element involved in cutting, loading, hauling, and milling, more information is needed as a basis for definite conclusions as to optimum depth and spacing of both open ditch and closed tile drains.

CONTROL OF GROUND WATER IN PEAT AND MUCK SOILS

Investigations on the control of ground water in peat and muck soils, to determine best water-table depths for various crops, were continued at the Everglades Experiment Station near Belle Glade in cooperation with the Florida Agricultural Experiment Station.

Results show an average per acre of 55 tons of sugarcane yielding 11,200 pounds of sugar from 13-inch-depth plots, and 55.32 tons yielding 10,724 pounds of sugar from the 38-inch-depth plots. These results were contrary to expectations, as it is commonly believed the water table should be low during the latter part of the season to increase sugar concentration. Plots irrigated during April and May produced only slightly more than unirrigated land. Similar experiments on green beans gave yields per acre of 121 hampers from a 13-inch water depth plot and 322 hampers from an 18-inch water depth plot and show the importance of maintaining the lower depth of water for beans. Yields from other plots with water tables of 24 to 36 inches varied from 207 to 268 hampers per acre. Experiments with Dallas grass indicated the deeper water tables were most conducive to high yields.

Studies of the amount and rate of subsidence of peat soil in Florida have revealed that the ultimate useful life of some 3½ million acres of peat land in Florida, and many other smaller peat areas in the United States, is directly related to proper ground-water control. Measurements over more than 20 years show that in representative areas having original peat and muck soil depths

of about 12 feet, subsidence following drainage has now amounted to more than 5 feet.

Measurements of subsidence were made on eight plots having controlled water tables. On these plots the subsidence for the year varied from 0.7 inch on a 13-inch-depth plot, to 2.4 inches on a 38-inch-depth plot, indicating subsidence losses are roughly proportional to the depth of water table and that a high water table helps to conserve the soil. Analyses conducted by chemists of the Everglades Experiment Station reveal subsidence due to slow oxidation caused by bacterial action also varies in proportion to the depth of water table.

To determine the necessary rate of water removal and the quantity of water to be removed to maintain satisfactory drainage conditions on the peat and muck lands of southern Florida and to determine costs of ground-water control, records of pumping operations were continued at four drainage district plants serving a total area of 21,508 acres, most of it in cultivation.

Automatic water-level records were obtained from five well lines located near Lake Okeechobee and several laboratory experiments were conducted to analyze the rate and direction of seepage movements through the ground. The results show that as the top portion of the soil is changed by drainage and cultivation from undisturbed porous saw-grass peat soil into a muck condition, the rate of seepage is greatly reduced, and that soil water reaches its drainage outlets primarily through a vertical movement into the porous sand or rock beneath and thence laterally to the ditches. This information on direction of seepage is further substantiated by comparing ground-water levels and gradients existing along the south shore of Lake Okeechobee before and after construction of the new levee. Although this levee was strengthened by excavating a core trench to rock beneath the levee and refilling with marl in an attempt to reduce seepage, it has had little or no effect on the water table in adjacent lands.

IRRIGATION IN THE HUMID REGION

The severe drought conditions that existed in many sections of the humid region during the summer of 1936 resulted in many requests for information on irrigation equipment to supplement rainfall during drought periods. There are now nearly 1,000,000 acres under irrigation in the humid region of the eastern half of the United States.

The investigations on the irrigation of strawberries being carried on at Willard, N. C., in cooperation with the Agricultural Experiment Station of the University of North Carolina, the North Carolina Department of Agriculture, and the Bureau of Plant Industry, continue to show that irrigation of strawberries in eastern North Carolina is profitable. Some of the irrigation treatments on experimental tracts brought increases in yield as large as 400 quarts per acre over the best unirrigated plots, and nearly 1,000 quarts per acre above the average of the unirrigated plots. Results also showed irrigation improved the quality of berries and increased the percentage of marketable fruit.

Similar investigations on strawberries in 1936 at Salisbury, Md., in cooperation with the University of Maryland and the Bureau of Plant Industry, showed consistent irrigation was very beneficial and demonstrated the possibility of maintaining superior plant beds through the second harvest season.

Using the estimate of 947,292 acres reported in 1936, by a committee of the American Society of Agricultural Engineers as a basis, it appears that approximately 83,500 acres of land east of the 100th meridian, the humid part of the country, are equipped for the supplemental irrigation of truck or garden vegetables, 51,000 acres for the growing of orchard fruits, 614,000 for the growing of rice, and the balance, nearly 200,000 acres, for the growing of the more ordinary farm crops. More than 26,000 acres of the land devoted to truck are equipped with the very expensive sprinkling irrigation, mostly overhead-pipe type.

CIVILIAN CONSERVATION CORPS DRAINAGE CAMPS

The 46 drainage camps of the C. C. C. assigned to the Bureau of Agricultural Engineering during the year maintained and made more effective public drainage improvements benefiting several million acres of highly developed agricultural land in Maryland, Delaware, Ohio, Indiana, Illinois, Iowa, Missouri, Kentucky, and Louisiana, by clearing, cleaning, and repairing approximately 4,600 miles of channels, levees, and tile drains, and by building many small drainage and erosion-control structures. The combined projects represent more

than 1,250,000 man-days of work. The commercial value of these operations is estimated at $5,250,000 based on contract prices for doing similar work.

This work has resulted in wide recognition by landowners of the need for adequate maintenance of drainage improvements and of the benefits resulting from it. During years of drought and depression, drainage systems deteriorated badly, many organized drainage districts failed financially, and a great many landowners suffered crop losses as a result of poor drainage. In the short time the camps have been operated, many drainage and flood-control systems have been put back in a good state of repair. Drainage district officials have cooperated in extending the beneficial effects of the camp programs by providing funds, materials, equipment, and other assistance worth approximately $1,250,000.

This practical C. C. C. drainage program is limited to the maintenance of public drainage improvements of organized districts and county drains already constructed. Work is confined to projects benefiting land which is unquestionably of high agricultural value when properly drained. New work is not authorized and no swamps are being drained. Projects which would bring additional lands into cultivation, keep lands of poor fertility or submarginal character in cultivation or reclaim new farms, are not undertaken. No work is done on private drains.

Aside from the regular work projects and the education and training of the men enrolled, the camps are developing much valuable information, pertaining to economical drainage-ditch-maintenance methods. Available maintenance equipment has not proved entirely satisfactory and attention is being given to developing smaller, more adaptable, and effective and less costly mechanical equipment for use in clearing, cleaning, and maintaining ditches. These investigations have included tractors equipped with winches and scrapers for side-channel cleaning, special excavators consisting of double-drum hoists mounted on truck chassis and provided with a light stationary boom for power return of the empty scraper to the ditch, heavy-duty mowers for use in cutting vegetation and small tree sprouts along ditch banks, apparatus for pulling clumps of willows out by the roots, and for cleaning silt deposits from tile or road culverts. Channels are being cleared and cleaned by hand labor, explosives, burning, and poisoning, to determine most effective and economical possibilities. Open ditches are being constructed with various side slopes and seeded to different kinds of grasses to obtain information on establishing the most stable channels.

Measurements of stream flow are being obtained under various conditions of channel efficiencies with a view of establishing reliable data on coefficients used in formulas for computing flow of water. These data will also indicate the amount of increase in channel-carrying capacity resulting from ditch clean-outs and the effect of providing a properly functioning drainage-maintenance program. Rainfall observations in connection with measured run-off quantities will also indicate required capacities for systems draining various sized watersheds under different topographical and land-use conditions.

DIVISION OF IRRIGATION

DUTY OF WATER

An important result of recent studies on the duty of water in pear orchards is the proof that at least on heavy clay soils, soil moisture becomes less readily available to the trees as it declines in amount. These researches were carried on at the Southern Oregon Experiment Station at Medford, and the 1936 results substantiated those obtained there in previous years. So far, the results on light soils are not conclusive.

Experiments now show that soil-moisture availability to trees is the important limiting factor in controlling fruit set and yield. Pruning simply modifies the size of the transpiring surface and is a means of maintaining a suitable balance between water income through roots and outgo through leaves.

One of the major accomplishments of the year was the successful initiation of the so-called "valley soil-moisture control project" near Medford. This project was designed to apply results obtained at the Medford station to commercial orcharding. The project was conducted by the Division in cooperation with the Oregon Extension Service through the office of the local county agent and with the help of the Works Progress Administration. Soil-moisture conditions

were determined in 21 commercial orchard blocks, a total of 350 acres, and from these records the operators were advised as to the proper time to irrigate.

At the Pomona (Calif.) station studies were concentrated on the irrigation of citrus fruits. Field trials were continued in which the periods between irrigations were determined by measurements of lemons. Three treatments were used again on a heavy soil at San Dimas. On the control plot irrigations were made frequently enough so the fruit grew continuously. A second plot was irrigated after the first significant decline in fruit growth, and a third plot after water deficit had for some time been apparent from fruit measurements but before definite wilting. Fruit measurements give indications of impending water shortage. Similar trials were made on a sandy soil at Claremont, Calif. These tests showed irrigation may be delayed until the first decline in growth of fruit without causing a significant reduction in the size of fruit at harvest.

Through cooperation with the Los Angeles County farm adviser records of fruit growth in relation to irrigation interval have been obtained from several hundred trees in commercial orchards. In 1935 and 1936 experiments were tried in which the differences in treatment were based on water deficit as indicated by measurements of fruit. Three treatments were used in which the differences were made large. Rate of growth and ultimate size of fruit were the measures of results. Records of yields were not obtained. The reliability and practicability of this system of establishing differences between plots were demonstrated. The results indicate that small water deficits may be allowed to develop before each irrigation without materially influencing the size of fruit. It is now proposed to set up long-time trials in which the differences between treatments will be relatively small. Two-year records of yields will be obtained before the trials are started; the trials will then continue for from 3 to 5 years, or until differences in rates of growth and size of fruit become apparent.

In cooperation with the Division of Western Irrigation Agriculture of the Bureau of Plant Industry, preliminary work was started to study the effect of the saline irrigation waters on foothill orchards. This procedure consists essentially in applying measured quantities of saline waters to a Washington navel orange orchard, and noting the effects on soil solution, rate of percolation, and condition of trees.

Citrus-fruit-measurement studies were continued at the Phoenix (Ariz.) station. Fruits were tagged in four grapefruit orchards, three Washington Navel orange orchards, and one Valencia orange grove, and the circumferences recorded about twice a week. The rate of growth indicated accurately when water should be applied. In one grove fruit on two adjoining trees of the same age was measured, one a Washington Navel orange and the other a grapefruit. During the summer the grapefruit stopped growing in 16 days after irrigation, but the orange grew at a uniform rate for 21 days. This indication is in line with that of a previous study which showed that grapefruit uses 20 percent more water than Washington Navel oranges. In another grove the fruit on a Washington Navel orange tree, a Valencia orange tree, and a grapefruit tree were measured. The trees were separated from each other by about 10 rows of trees. The Valencia oranges showed shrinkage before the grapefruit, although the grapefruit tree was more than twice as large as the orange tree. This result may be charged partly to soil differences. However, the little Valencia trees appeared to wilt as soon as the larger grapefruit trees.

In studies at Phoenix on use of irrigation water by Pima cotton, 12 plots were grown on the University Farm at Mesa on a clay loam with a water-holding capacity of about 16.5 percent and a wilting point of about 8.5 percent. The results indicate the superior value of early irrigations, contrary to the belief of many Salt River Valley farmers that the first irrigation should be delayed as long as possible, but that once irrigation is started the soil should not be allowed to dry.

The 1936 season was the fifth year the use of water for field crops has been studied at the Yuma Field Station (near Bard, Calif.). Water conditions there are constantly changing and it will be difficult to obtain good results until they become stable. Before its storage behind Boulder Dam, the irrigation water contained large quantities of fine silt which caused it to percolate slowly, while now it is fairly clear and contains only a bed load of fine sand. Percolation losses are greater and more water is applied per irrigation. During the 1936 season, wheat used 62 percent more water than a previous 4-year average; citrus, 29 percent; cotton, 15 percent; barley, 22 percent; corn, 21

percent; young alfalfa, 6 percent; and mature alfalfa, 11 percent. Yields of the principal crop increased. Young alfalfa produced 49 percent more than the previous 4-year average; mature alfalfa, 33 percent more hay; cotton, 18 percent more seed cotton; and barley, 13 percent more grain. One cotton plot, using 57.93 acre-inches of water, produced 3,596 pounds of seed cotton (Acala variety) per acre, the largest yield ever recorded at the station. Mature alfalfa produced 15,480 pounds of cured hay per acre, using 66.02 acre-inches of water: and barley 1,868 pounds of grain per acre, using 31.65 acre-inches.

Measurements of citrus fruits in studies of use of water have been carried on at the Yuma station to supply information under different climatic, water, and soil conditions than are found at Pomona where similar work is going on.

Ground-water data have been gathered for about 2 years from large observation wells equipped with automatic recorders. These key wells are used in conjunction with smaller iron-pipe wells equipped with strainer joints. The small wells are read twice a week. The value of the key wells is in affording a continuous record of ground-water behavior. The recorded data will be valuable as indicative of ground-water fluctuations before marked changes have been brought about by changes in the quality of the irrigation water, irrigation practices, and seepage losses from the All-American Canal and Colorado River.

The rise of the ground-water and the anticipated continued rise are of serious importance. During March 1937, with the irrigation season just beginning, the water table was higher than at the end of the 1936 irrigation season. Before definite plans can be formulated to relieve the situation, careful and extensive studies should be made of the ground-water behavior.

A cooperative project participated in by the Bureau of Agricultural Engineering, the Bureau of Reclamation, the Bureau of Plant Industry, and the Indian Irrigation Service, and leading to a complete study of the underground-water conditions is about to be started and will be carried on for several years.

In the Scottsbluff (Nebr.) studies of duty of water, carried on in cooperation with the Division of Western Irrigation Agriculture of the Bureau of Plant Industry, experimental work was conducted on small plots where the amounts of water and time of application were varied. For sugar beets the results were about the same as last year, the best yields being obtained from application of 15 to 20 inches.

The average water use of the various crops, on the basis of 4 and 5 years experimentation, appears in table 1. From this it will be noted that the water use for the past season is somewhat below the average for the previous 4 years.

TABLE 1.—*Water use by beets, alfalfa, potatoes, and oats*

Crop	4-year basis	5-year basis	Difference
	Acre-inches	*Acre-inches*	*Acre-inch*
Beets	24.27	23.90	0.37
Alfalfa	26.68	25.88	.80
Potatoes	14.39	13.61	.78
Oats	14.72	14.18	.54

Under an agreement with the National Resources Committee, the Bureau made an estimate of the consumptive use of water in the major divisions of Rio Grande Basin above Fort Quitman, Tex., and mapped and tabulated the areas in agricultural crops and water-consuming native vegetation. Field work was completed in the fall of 1936, and a report was submitted to the committee in April 1937.

Involved in the studies was about 700 miles of Rio Grande's length, and altitudes covering a range of 6,000 feet, with consequent variations of climate and soil and wide differences in acreages and kinds of crops. The total acreage covered was 2,092,817. Of this 923,594 was irrigated land, 948,171 native vegetation, and 221,052 miscellaneous areas.

The waters of Rio Grande above Fort Quitman are largely consumed by native vegetation and irrigated crops in Colorado, New Mexico, Texas, and Mexico. In the usual year very little water in the Rio Grande Basin above Fort Quitman escapes from it unconsumed, and that small part consists mostly of unusable return flow and flood-peak flows originating below Elephant Butte Reservoir.

Estimates of average annual unit consumptive use requirements (including precipitation) along the main stem of Rio Grande are shown in table 2.

TABLE 2.—*Average consumptive use of water per acre*

Location	Irrigated lands	Native vegetation	Miscellaneous areas	Total area mapped
	Acre-feet	*Acre-feet*	*Acre-feet*	*Acre-feet*
San Luis Valley, Colo	1.7	1.4	1.2	1.51
Colorado-New Mexico, State line to San Marcial, N. Mex	2.6	3.6	3.2	3.2
San Marcial, N. Mex. to Fort Quitman, Tex	2.8	4.0	3.7	3.2

In carrying out the Rio Grande Basin project, for which funds, men, and time were limited, a Bureau engineer developed a new method of estimating acreages in various crops and native vegetation. Maps were made from the air, and after the patches in different crops had been identified they were numbered in 18 classifications. The maps were then covered with uniform thin celluloid sheets of known weight and the outlines of various crops and other areas scratched into them along with the numbers. The sheets were then cut or broken up along the outlines, the pieces sorted and the various groups weighed on an accurate balance. The method proved a very rapid and accurate way to determine acreages used for various purposes.

In cooperation with the New Mexico Agricultural Experiment Station studies were made on consumptive use of water by crops and by moist-area native vegetation in Mesilla Valley, N. Mex.

Special studies of duty of water and on the rate of flow of capillary moisture have been carried on at Corvallis, Oreg. This project was largely financed by the Works Progress Administration and sponsored by the Oregon Agricultural College. The results of the first part of the study have been submitted for publication. The report includes information on the rate of flow of moisture in soil with moisture content between the wilting point and the field capacity, The second part of the study, now under way, is designed to determine both the force causing capillary flow and the resistance to that flow in terms of absolute units of length, mass, and time.

EVAPORATION STUDIES

In the evaporation studies in southern California much has been done in arranging records of evaporation from pans of different sizes and types in several localities to establish measures of comparability. The end in view is the making of accurate estimates of evaporation losses from large bodies of water, especially irrigation storages. Present studies are carried on directly in agricultural valleys, in coastal, intermediate, and desert climates, and indirectly in a nearby mountain canyon.

The year 1936 saw the completion of 4½ years' records of evaporation at the cooperative Baldwin Park key station; of 2 years at the Fullerton station; of 5½ years at the cooperative Prado station; of 1 year's cooperative work at the United States Yuma Field Station at Bard, Calif.; and 1 year's record of evaporation from the surface of a ventilated, covered reservoir at La Verne. Indirectly the Division of Irrigation is interested in the San Gabriel Canyon station operated by the water department of the city of Pasadena, where records have been obtained for the past 6 years.

Analysis of records show that evaporation coefficients are variable each month and not constant throughout the year. Evidence tends to show, also, that the same coefficients may not apply to all geographical areas. The amount and value of any such differences, however, may be determined only by extended investigations in many parts of the West.

SILT IN STREAMS AND RESERVOIRS

During the year 1936–37 samples were received and percentages of silt determined for nine regular silt-sampling stations as follows: at Roma and Eagle Pass on Rio Grande; near Three Rivers on Nueces River; near San Saba on Colorado River; at Richmond on Brazos River; at Romayor on Trinity River; near Rockland on Neches River; at Logansport on Sabine River; and near Denison on Red River.

The stations on the Rio Grande are maintained in cooperation with the International Boundary Commission, sampling at Romayor is done in cooperation with the city of Houston, and samples near Denison were taken (prior to April 27) in cooperation with the War Department. For the fiscal year 1937 more than 7,000 water samples have been received from these regular sampling stations and the percentage of silt in each has been determined. Computation and compilation of summaries of total silt carried at each regular station during the water year 1935–36 were also made for the fiscal year 1937.

It is believed desirable that at least a 10- to 15-year silt record be obtained at each silt-sampling station, so that fair average values may be determined. This general rule should be subject, of course, to material changes in the various watersheds, such as construction of large dams. By June 30, 1938, the length of record at each of the nine stations will be approximately as follows: Richmond, 13 years; Three Rivers, 9¾; Roma, 8¼; Rockland, 7; San Saba, 6¾; Logansport, 4; Denison, 4; Eagle Pass, 3¼ years; and Romayor, 11 months.

PUMPING FOR IRRIGATION

The manuscript of a bulletin on Irrigation Wells and Their Construction is in preparation and another on pumping machinery is planned.

DESIGN AND INVENTION OF IRRIGATION APPARATUS

Some advance has been made in the design of the Parshall measuring flume, particularly with reference to reducing interference by storm debris.

Notable progress has also been made in the improvement of the vortex tube sand trap for irrigation flumes and the adjustable tube orifice for measuring water in flumes. Because it is difficult to observe the pressure head on the adjustable tube orifice with this type of meter, it has not been considered altogether practical, but apparatus now set up is intended to demonstrate the possibility of a new method of reading the effective pressure head on the flow through the meter.

A new current meter-rating station was designed and built in 1936 in cooperation with the Colorado Agricultural Experiment Station.

Use of the Parshall measuring flume has been suggested in measuring flood flows. The Division of Irrigation has been reluctant to recommend such use under conditions where the discharge varies widely, when large quantites of debris would be carried through the structure, or where channel grades are excessive.

The selection of a small flume with high walls should permit of good control, and at the same time promote high velocities for moving the bed load through the structure. It is possible that the law of discharge can be extended for flows where the head is as much as three times the throat width. In short, it is believed that the Parshall flume can be improved to approach more closely the requirements in measuring flood flows. It is not intended to change the dimensions of the flume but to improve the method of determining the effective heads in such a way that a consistent relation of head and discharge can be established irrespective of the nature of the flow. For the solution of this problem, a gage at the upper end of the flume is proposed. Readings on the three gages H_a, H_b, and H_c will show the condition under which the flume is operating and, it is hoped, be made the basis of a method of determining the discharge. A practical method of recording these three heads simultaneously on an instrument chart has not been found. For flood flows where the stream is carrying large quantities of debris, the problems of making piezometers and stilling wells operate satisfactorily will have to be given consideration.

SPREADING WATER FOR UNDERGROUND STORAGE

The results found in studies on the several phases of spreading water for underground storage were being prepared for publication.

A study has been continued, however, in order to check the experimental results against actual large-scale spreading operations. This past precipitation season is the first since 1926 when water has been available for actual spreading over the various spreading units.

There has been little opportunity to measure the effect of the rainy season just past on the underground water, principally on account of the generally deficient rainfall during the past 20 years. During this 20-year period, there has been a general downward trend in water levels, broken temporarily by years of abnormal rainfall. Following the wet seasons of 1914–15 and 1915–16 there

was considerable recharge as shown by rising levels in many wells. Improvement, however, was not permanent.

What seems to be the most important effect of the past season's rainfall is the larger amount of water in surface storage in flood-control and irrigation, power, and municipal reservoirs. The previous seasons saw heavy drafts on surface-stored water until actual depletion resulted. This in turn meant more drafts on underground storage.

In the Santa Clara Valley and the Winters area of central California well readings show beneficial effects of the season's abundant rainfall on the underground levels, but the so-called "hump" must flatten out before the true conditions can be ascertained. The belief, however, is that there will be considerable benefit.

SNOW SURVEYS FOR FORECASTING IRRIGATION WATER SUPPLY

Much of the uncertainty regarding water supplies and soil moisture which has prevailed throughout the irrigated areas of the West in the past has been dispelled this year because of the run-off forecast program based on snow surveys. With minor exceptions, adequate irrigation water supplies, good grazing conditions, and absence of flood hazards were predicted this year. Where actual measurements of water have been made later the forecasts have proved accurate to a high degree.

Particular attention has been given to prompt release of snow data and forecast reports. Monthly mimeographed reports were circulated, radio stations and the press were utilized in broadcasting the information, and the Weather Bureau published complete reports in its Climatological Summary for April and May 1937.

Although the service is intended primarily for irrigation interests, it is being eagerly sought and used by forest officers interested in forest-fire prevention, by officers and operators of municipal water systems and power companies, by fish and game commissions, by lending agencies dealing with agricultural loans, and by winter-sports projects.

The snow-course network in Oregon and northern California was expanded by the addition of 18 new courses. There are now 66 standard snow courses in Oregon, 14 of these operated by the California Oregon Power Co., at which water content of a measured sample is determined by melting. Sixteen new courses were established in Colorado and Wyoming, and all stations from which the courses were operated were equipped with sampling and weighing apparatus.

The projects dealing with flow of water in irrigation conduits; customs, regulations, and laws pertaining to irrigation, and drainage of irrigated lands were inactive during the year chiefly owing to assignment of the personnel to other work, but it is expected that these studies will be resumed in the coming fiscal year.

DIVISION OF MECHANICAL EQUIPMENT

COTTON PRODUCTION MACHINERY

Results of tests conducted during the past 5 years on machinery and methods for seedbed preparation, planting, and cultivation of cotton in cooperation with the Alabama Agricultural Experiment Station on Red Bay (formerly Greenville) sandy loam near Prattville, Ala., show conclusively that tillage methods influence both yield and staple length of this crop.

Highest returns in yield and quality of cotton were obtained where the seedbed was prepared 60 days before planting and to a depth of about 8 inches. At planting time the beds were leveled to the desired height with a broad sweep, the seed planted in the firm soil thus uncovered, and the crop cultivated only often enough to control weeds. This method reduces power and labor requirements and is being adopted by farmers in Alabama.

Results of seedbed-preparation studies indicate that beds should be made high enough at the start to permit shaving off the top and leaving them 1 to 2 inches above the middle at planting time. Bedding sweeps recently developed by Bureau engineers consists of spring steel bars welded to a 26-inch sweep. The unit has a total width of 32 inches and the bars throw most of the dirt onto the bed but allow some to sift through, producing a mulch in the middles which tends to retard run-off. These sweeps have proved especially adaptable when mounted on a middlebuster frame for tractor operation.

The variable-depth cotton planter developed by the Bureau continues to show satisfactory results. In no case was it necessary to replant although on many

neighboring farms, where planters of the conventional type were used, much replanting was necessary. Four manufacturers offered variable depth planters to the trade in 1937 and some farmers are making their own units.

Studies recently begun in turning under cover crops show that the equipment used affects the gross returns by influencing the yield, quality, and length of staple of the following cotton crop. The maximum returns, based on 1 year's results, were obtained on plots where the cover crop (vetch) was turned under with a large-base moldboard plow. The vertical disk plow with 24-inch disk with 10- to 12-inch spacing, also produced favorable results. This latter is of particular significance as these plows may be obtained in sizes to fit the power units available on different size farms. In turning under a cover crop such plows will also cover a greater acreage per day with a lower power consumption than the moldboard type. The vertical disk plow did its best work at a speed of 4 to 5 miles per hour.

TILLAGE MACHINERY LABORATORY

The facilities at the farm tillage machinery laboratory, Auburn, Ala., have been improved during the past year by the addition of some shop equipment, a plot fitting unit, and one additional soil type. The following soils are now in place: Decatur clay loam, Davidson clay, Norfolk sand, Lufkin clay, Cecil clay, Davidson loam, Eutaw clay, Houston clay, Oktibbeha clay, and Sharkey clay.

Tests of plow bottoms in these soils during the past year have been confined to lighter soil types and to the moldboard type of plow. Tests thus far show that the draft of conventional moldboard plows increases rapidly with increase in speed as shown by table 3. This is of especial significance in view of the trend toward higher ground speed of field machinery made possible by pneumatic tires. If plows are to be pulled at a higher ground speed changes in design must be made in order to reduce power requirements.

TABLE 3.—*Draft per square inch of furrow slice for 4 plow bottoms in 2 soil types for speeds of 1 to 8 miles per hour and at 6-inch depth*

Speed (miles per hour)	Sandy soil				Loam soil			
	12-inch bottom	14-inch bottom	16-inch bottom	18-inch bottom	12-inch bottom	14-inch bottom	16-inch bottom	18-inch bottom
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1	2.35	2.13	2.13	2.35	3.86	3.30	3.45	3.19
2	2.41	2.15	2.34	2.42	4.14	3.72	3.57	3.60
3	2.51	2.30	2.63	2.59	4.54	4.18	3.91	4.06
4	2.72	2.58	3.00	2.86	5.09	4.68	4.46	4.57
5	3.03	2.97	3.43	3.21	5.77	5.22	5.22	5.10
6	3.42	3.48	3.94	3.65	6.59	5.80	6.19	5.69
7	3.90	4.10	4.51	4.19	7.54	6.42	7.39	6.32
8	4.46	4.85	5.16	4.82	8.63	7.08	8.79	6.99

Results of tests on several soil plots also show one depth for each type of plow bottom for minimum draft.

CORN PRODUCTION MACHINERY

In continuing the corn-production-machinery project in cooperation with the Iowa Agricultural Experiment Station, attention has been given to planting, cultivating, and harvesting operations.

The study of hill spacing of check-planted corn was continued as a comparison of 21- by 21-, 30- by 30-, and 42- by 42-inch spacing. A hand-planted spacing experiment was carried on in cooperation with the field crops section of the experiment station. Under the conditions of 1936 there was no significant difference in yield due to row spacing. This conforms with results obtained in the dry year 1934. In 1935, under favorable growing conditions, the 21- by 21-inch spacing yielded 74 bushels per acre, the 30- by 30-inch produced 64 bushels, while the 42- by 42-inch spacing gave a yield of only 59 bushels.

It has been found difficult to do accurate checkrowing of corn with a four-row planter. Inaccurate checkrowing slows up cross cultivation and results in some damage to plants. For this reason a study of checkrowing devices has

been made during the past 5 years. During the current year an experimental checkrower has been developed which, in preliminary tests, has produced a high degree of accuracy in check planting.

Studies of early cultivation of corn were continued with the following machines: Spike-tooth harrow, spring-tooth weeder, rotary hoe, and cultivator with rotary-hoe wheels near the row and sweeps between rows. Plots which received no early cultivation yielded as well as any of the others. These results agree with those obtained in 1934; but in 1935, when wet weather prevented timely cultivation during the latter part of June, the plots given early cultivation with the cultivator yielded about 12 bushels per acre more than the check plots, while early cultivation with spike-tooth harrow, spring-tooth weeder and rotary hoe produced yield increases of from 3 to 5 bushels per acre. These results show that early cultivation was not beneficial when conditions permitted timely and thorough cultivation after the plants had reached 6 to 8 inches; but under wet conditions thorough early cultivation was very beneficial.

Surface planting, listing, and basin listing were compared in nine replications in each of two fields in 1936. The surface-planted corn yielded much better than listed or basin listed corn in both fields.

In an experiment in basin listing in which different locations of the seed were compared, the yield was better where the seed was drilled in a continuous row than where it was all placed either in the basins or in the dams, showing that nothing is gained by synchronizing seeding and damming.

In comparing different methods of preparing the soil for basin listing, the results were as follows: Compared to the plots which received no fall preparation, fall plowing 8 inches deep caused an increase in yield of 15.4 bushels per acre; fall plowing 3 inches deep caused an increase in yield of 7.6 bushels per acre; and blank basin listing in the fall, an increase in yield of 3.5 bushels per acre. Chiseling 10 inches deep in the fall gave no increase in yield. This new phase of the investigations will be continued.

Five different corn hybrids were tested for adaptability to machine harvesting. Shelling losses were high in the case of a northern, early-maturing hybrid. Between four hybrids adapted to central Iowa no material difference was found in their adaptability to machine harvesting as measured by field losses.

Field testing of corn pickers and study of corn-picker design were continued. Special attention was given to the performance of pick-up and snapping mechanisms since it has been shown that field losses of corn in harvesting are due almost entirely to failure of these units to perform satisfactorily under all conditions.

SUGAR-BEET PRODUCTION MACHINERY

In cooperation with the Agricultural Experiment stations of Colorado and California progress has been made in reducing the peak hand-labor load in cultivating and harvesting sugar beets.

Improvement of a planter which will place individual seed balls accurately at short intervals is under way. Experimental work on mechanical blocking of beets planted with conventional type planters shows savings in blocking and thinning costs of from 10 to 40 percent. With beets planted uniformly so that the slow thinning of bunches of seedlings can be largely eliminated, even greater savings can be made.

A sugar-beet harvester representing the latest development in commercial equipment was tested during the 1936 season. Tests were made over a wide range of soil, climatic, and crop conditions at several locations in California, Colorado, and Iowa. The climatic and soil conditions under which such a machine must operate vary widely, as does the size of beets. In California the weather is likely to be hot at harvest time and the soil dry. In Colorado rain may be frequent and irrigation late. In Iowa there is likelihood of mud and frozen ground during harvest. Yields in California may be in excess of 30 tons per acre. In other locations yields may be less than 15 tons. Mechanically the harvester gave little trouble. Under the favorable conditions in Colorado in 1936 machine harvesting cost less than hand topping and quality of work was equally good. Under the most adverse conditions in Iowa it was necessary that a man follow the machine to glean missed beets and do hand trimming, but the cost was still less than by customary methods. In California, under extreme conditions, the machine handled the heavy tonnage, but because of the hard soil some beets were left.

COMBINES

The increase in acreage of soybeans in the Corn Belt and the introduction of rubber tires for field machinery has further stimulated improvements in the design of combines. Power take-off machines mounted on rubber tires with 5-foot cut were placed on the market in limited numbers in 1935 by two firms. In 1936 at least three firms were in production of either 5- or 6-foot machines and possibly 10,000 were sold. Practically all manufacturers of combines had a small machine for the 1937 harvest and sales were expected to be double or treble those of 1936. While small grain and soybeans are the principal crops harvested, one manufacturer gives operating instructions for 68 different crops.

"Baby" combines are usually pulled at from 0.5 to 1 mile per hour faster than larger combines, thus compensating in part for the narrow swath. A somewhat greater threshing and separating capacity per foot width of cut and the use of rubber tires make possible this increase in speed. They are frequently pulled at 5 miles per hour.

There appears to be no significant difference between size of combine and grain losses. In combining wheat under favorable conditions, cutter-bar losses were about the same for the 5- and 6-foot machines as for larger sizes, but machine losses (threshed and unthreshed grain thrown out with the straw) were lower for the baby combine. With soybeans in 1935, total losses for the small and large machines tested were practically the same. In 1936, low cutter-bar losses for the 8-foot and larger sizes resulted in a lower total loss for this size group than for the 5- and 6-foot machines. The small combines due to light weight and pneumatic tires can be operated to better advantage over ridged rows and on soft ground than the large machines. The increased threshing and separating capacity per unit width of cut also favors the small machines in rank-growing crops and in weedy fields.

PYRETHRUM HARVESTING

Work has been continued in cooperation with the Bureau of Plant Industry in the development of equipment for harvesting pyrethrum. A machine of the stripper type, somewhat like a cotton stripper, appears the most promising. Such a machine will usually harvest from 80 to 95 percent of the flowers from the standing plants.

The experimental machine has stripping rollers 4 feet long set at approximately 30° with the horizontal. The machine straddles the row and the plants pass between the rapidly revolving rollers. Pick-up chains similar to those used on corn binders lift leaning or lodged plants. Adjustments are provided for changing the speed and spacing of the rollers. Provisions are also made for attaching either 5 or 10 stripping bars of angle iron to each of the rollers in opposed or staggered position. Rubber-faced stripping bars have also been obtained for test purposes. The flowers, after being stripped from the plants, fall on conveyors which deposit them in a container on the machine.

MECHANICAL HARVESTING OF COTTON

The Bureau in cooperation with the Bureau of Agricultural Economics and the Mississippi Agricultural Experiment Station, tested a mechanical cotton picker during the fall of 1936 at the Delta Branch Experiment Station, Stoneville, Miss., and ginning tests of the cotton picked were made at the Bureau's cotton ginning laboratories at Stoneville.

Preliminary classification of cotton samples showed that mechanically picked cotton, under the 1936 test conditions, was of a somewhat lower grade than that of normal hand-picked cotton.

When drawn by a tractor at 2.6 miles per hour slightly less than 1 acre per hour was picked the first time over, and slightly more than 1 acre per hour the second and third times over. The pounds picked per hour varied with the field yield, with an average of 703 pounds for the first time over and 173 pounds for the second. Approximately 75 percent of the cotton was picked the first time over and 16 percent the second, making a total of 91 percent, when the second picking followed immediately after the first. When picked by hand the field is usually gone over several times during the season, depending upon how uniformly the bolls open.

PEST-CONTROL EQUIPMENT

Plant pest-control projects are being carried on in cooperation with the Bureau of Entomology and Plant Quarantine and with entomologists and pathologists of the agricultural experiment stations.

The work on plow attachments for better coverage of crop residues for control of the European corn borer consisted principally in further tests of the self-aligning disk jointer under different soil conditions and the improvement in design of trash guides for use with the disk jointer. The wheelbarrow sprayer for treating sweet corn for corn borer control has been redesigned and made more suitable for field applications of insecticides. Considerable effort will be made to adapt dusting equipment for use on corn.

Development work continues on lead arsenate distributors for applying accurate dosages of poison to soil for control of Japanese beetle grubs. This practice is effective in nurseries and gardens, but there is no equipment which will apply exact amounts of material. If the field tests prove the experimental spreader satisfactory, a large unit will be built. Such a spreader would be useful in the control of other soil pests. Cultivating equipment is being adapted for mixing the poison with soil after the accurate dosage is applied by the spreader.

Investigational work with water vapor for applying insecticides and fungicides was continued in cooperation with the Bureau of Entomology and Plant Quarantine and the Ohio Agricultural Experiment Station. The apparatus for producing the vapor spray consists of a small flash-type boiler burning furnace oil. Water is pumped through coils in the boiler where it is heated and, when released, it bursts into a fine vapor. The insecticide or fungicide in a concentrated liquid form is pumped into the vapor line beyond the boiler coils and becomes thoroughly mixed with the vapor. The resulting spray has considerable driving force and good covering qualities. A one-horsepower gasoline engine furnishes the power for the fuel, water, and spray solution pumps and the blower fan for the burner. The capacity of the unit last season was 1¼ gallons per minute, but by redesigning parts of the machine the capacity has now been raised to 2½ gallons.

During the past season the vapor spray was applied for control of pea aphis, apple scab, codling moth, cherry leaf spot, grape berry moth, grape rootworm, and various potato and vegetable insects and diseases. Only about one-fourth as much spray material was needed for satisfactory control as is necessary with the hydraulic sprayers.

An experimental burning of vineyard borders for control of leafhopper was conducted at Venice, Ohio, in the spring of 1936 and showed a marked effectiveness through the season. These borders were burned again in May 1937, and results will be checked through the present season.

A field duster for treating peas for the control of pea aphid was designed and constructed for use by the Bureau of Entomology and Plant Quarantine at Madison, Wis. This unit consists of two Root dusters both driven from a four-horsepower gasoline engine mounted on the rear of a ½-ton truck. The unit covers a width of 24 feet. For transportation through gates and on the highway the boom and dusters fold to a width of 7 feet. The total weight on the truck is 680 pounds. If this duster proves satisfactory for peas it should be suitable for dusting many vegetable and field crops.

FERTILIZER-DISTRIBUTING MACHINERY

Results of field experiments with several major crops have created widespread interest in better methods of applying commercial fertilizers and have stimulated the development of improved fertilizer-distributing machines. Devices which place the fertilizer in definite relation to the seed or plant as well as machines of new general designs have recently been developed. Many farmers have adopted the approved methods of applying fertilizers either by purchasing the required equipment or by proper manipulation of existing tillage, planting, and distributing machines. In some cases the desired equipment has been devised and built either by the growers or in local shops. The Bureau is participating in extensive cooperative research studies to obtain further improvements.

Fertilizer-placement experiments with lima, white, and wax beans, cabbage, celery, cotton, kale, peas, potatoes, spinach, sugar beets, tobacco, and tomatoes in the States of Colorado, Georgia, Maryland, Michigan, Mississippi, New York, North Carolina, Ohio, Pennsylvania, South Carolina, and Virginia have been continued in cooperation with the Bureaus of Plant Industry and Chemistry and Soils, the National Joint Committee on Fertilizer Application, the National Fertilizer Association, and experiment stations in the respective States. Similar experiments involving alfalfa, corn, pasture, soybeans, and sweetpotatoes have been started in Delaware, Indiana, Maryland, Michigan, North Carolina, Ohio, and Virginia. Advice and assistance have been given to a number of State

experiment stations planning similar fertilizer-placement studies as well as studies of commercial machines, designed for more effective placement of fertilizer.

An essential requirement of fertilizer-depositing equipment, further substantiated by our field experiments with certain crops, is the placement of the fertilizer in a narrow band at the side of the row and at a depth which will insure the presence of adequate moisture under usual conditions. For such crops as beans, cotton, peas, potatoes, and tobacco the research findings in general indicate that fertilizer is most effective when placed at a distance of 2 to 3 inches to the side of the seed or plant and at a depth in the soil of not less than 3 inches. For a crop such as sugar beets and for relatively small applications of plant food the fertilizer apparently should be placed nearer the seed or plant. The results to date have shown that proper row applications of fertilizer are superior to broadcast applications and in the case of widely spaced plants or hills that further concentration of the material in short bands at the hill is advantageous at least under certain conditions. The heavily fertilized and closely spaced truck crops have not yet been subjected to an exhaustive study.

The best position for fertilizer in order to avoid early injurious effects and produce greatest benefit to the crop varied somewhat with the kind of crop, type of soil, rainfall, amount and kind of fertilizer, and possibly other factors. Early injurious effects were associated with a high concentration of fertilizer salts around the seed or seedling roots, and were most severe when soil moisture was low. Fertilizer applied in appreciable amounts directly under or near the seed or seedling roots has usually caused severe injury when little rain fell immediately after fertilizer application at time of planting. These early injurious effects are avoided by placing the fertilizer in a distinct band at the side of the row, the exact distance from the seed depending on the various conditions mentioned. It has been found that the fertilizer must be precisely placed within comparatively narrow limits in order to avoid early injury and at the same time obtain early and maximum benefit of the plant food. Proper placement of the fertilizer has been particularly advantageous under adverse conditions, when obtaining and maintaining a stand of plants was difficult. Under certain conditions some advantage may follow from placing a certain portion of the fertilizer near transplanted seedlings for immediate assimilation by the roots.

Since an exact and well-defined placement of the fertilizer is essential it is important that the definite limits under the various conditions for each crop be accurately determined. To meet certain requirements indicated by the field experiments new fertilizer depositors have been developed for a number of machines including planters and transplanters as well as distributors for fertilizer only. The design of such depositors differs materially. Since the experimental evidence has indicated that the placement of the fertilizer should be reasonably precise, the placements actually accomplished with present commercial machines should be determined by further field experiments.

FARM-OPERATING-EFFICIENCY INVESTIGATIONS

The aim of the farm-operating-efficiency investigations is to discover and evaluate the relationship between the engineering elements—power, labor, machinery, buildings, and land improvement—and establish a basic plan of development and operation in which these elements are in balance with each other, and in proper proportion for the systematic operation of the whole farm in the production of the most profitable combination of crops and livestock. The project provides for increased farm profit through the elimination of the wasteful use of land, labor, capital, and equipment, and through the application of the best scientific information pertaining to engineering, soils, crops, and livestock, and their management.

These investigations are continued along the lines established in 1929. The project has been expanded in three States—Michigan, Minnesota, and Ohio—and now includes 121 farms. Preliminary plans were developed for 15 Michigan farms, and complete plans are now being developed. Surveys and maps were completed for 11 farms in northern Minnesota, and development and operating plans are now being prepared. The project includes 25 cooperating farms in Minnesota, 15 in Michigan, 22 in Ohio, 25 in Virginia, 12 in North Carolina, 2 in South Carolina, and 20 in Georgia.

The cooperating farms are privately owned and privately operated, in most cases owner-operated. The farms, though typical of the agricultural regions in which they are located, represent a wide range of soils, climate, crops, types of agriculture, and period of operation. Types of farms include cotton, dairy, fruit,

grain, tobacco, and truck. In age, the farms represent an extreme span of 150 to 200 years in American agriculture.

Careful study of soils, drainage, erosion, size of field, field arrangement, power, machinery, buildings, equipment, conveniences, livestock, crops, rotations, labor, management, and finance, indicates the existence of maladjustment of production elements and enterprises in varying number and degree on each and every farm regardless of the age, the size, the location, or the type of farming.

This maladjustment results in dissipation of profits and unsatisfactory living conditions and can be cured only by the adoption of an operating and development plan bringing into balance the several production elements for the efficient production, processing, and marketing of crops and livestock. In this project such a plan is prepared for each farm, in cooperation with the farm owner and various specialists of the State agricultural college.

The range of engineering problems existing on these typical farms is indicated by the number and scope of improvements provided for in the operating plans. Seventy percent of the farms needed improvement in field arrangement, 47 in drainage, 44 in erosion control, 44 in stumping, 37 in machinery, 36 in buildings, and 32 in power. In addition, a smaller number of farms required improvements in the use of electric power, irrigation, water systems, sewage systems, stationary spray systems, and farm and home conveniences.

The new operating plans provided for decreasing the average number of fields on North Carolina farms from 19.3 to 6.8, and the average size of fields was increased from 3.9 to 11.6 acres. In Georgia, the average number of fields per farm was decreased from 28.4 to 7.7, and the size increased from 4.8 to 17.5 acres. Improved field arrangement involves stumping, drainage, terracing, and relocation of fences. Usually this can be accomplished at comparatively low cost. The principal benefits derived from improved field arrangement are: (1) In facility of establishing a soil-conserving crop rotation; (2) in better utilization of land resources; (3) in reduction of weather hazards to soil and crops; (4) in economy in the use of power, equipment, and labor in crop production.

The farms varied extremely in the power available. In Ohio the cultivated area per horse ranged from 7 to 32 acres; in Michigan, 7 to 39; and in Minnesota 7 to 15. These figures include tractor power reduced to horse equivalent. In revising the power plans, provision is made for an adequate amount of power for the timely accomplishment of the work, but surplus power and its accompanying high cost are eliminated.

A building problem of varying importance exists on every farm. Building problems were found to be of major importance on 36 percent of the farms. A survey of available buildings showed the following wide range: Ohio, 2,340 to 7,200 cubic feet per animal unit; and Michigan, 2,620 to 8,920. Obviously, some farms are carrying an excessive building burden, or the building facilities are not used to their greatest advantage, while other farms are handicapped by the lack of adequate buildings. In the development of the operating plans, building requirements are determined for sheltering, storing, processing, and servicing crops, animals, and machinery, and a long-time building program is developed so that there will be adequate buildings of the proper type to serve the farm but not a burden of unnecessary buildings to be maintained.

The operating plans are kept practical. Improvements are such as can be made with the resources of the farmer. Only such improvements are made as will add to the profit and satisfaction of farming over a period of years. Provision is made for the utilization of surplus labor in the making of physical improvements to fields, fences, buildings, farmsteads, and equipment.

The plans are not governed entirely by the physical and economic aspects of the farm business, since it is recognized that farming is a mode of life as well as a business. Engineering improvements are predominant in making farm life more satisfying through relief from drudgery, shorter working hours, better health by means of sanitation in water supply and sewage disposal, and greater comfort and convenience in the farm home. Paint in morbid colors may be effective in protecting farm buildings, but paint in wholesome colors will be equally effective and will also buoy the spirits of the farmer and his family. This viewpoint is carried out in the field and farmstead planning. Field lines, where practicable, are made straight, for efficiency, but farmstead lines are varied with curved drives and irregular plantings.

The study has revealed striking physical, social, and economic differences between farms and shows that each farm is an entity. The patterns of no two farms are alike. Progressive stages of this study have shown that, individually, most farms have vast undeveloped resources capable of being developed and coordinated for more profitable and satisfying operation.

COTTON-GINNING INVESTIGATIONS

Nearly 2,400 tests were conducted on commercial saw-gin stands and auxiliary equipment in the cotton-ginning and fiber laboratories at Stoneville, Miss., during the year; they also made 1,470 tests on gin fans and piping. Engineers of the laboratories made field observations and endurance tests on saw cylinders during the ginning of approximately 50,000 bales of cotton handled by 11 plantation and public gins.

Two schools to give State cotton-ginning extension specialists a good understanding of recent findings of the ginning laboratory were held during the year. Eleven States were represented. The principal subjects included in the course were cotton conditioning, cleaning, extracting, and ginning. Instruments for making field inspections were demonstrated and the men were provided with enlarged photographs illustrating the most essential features of the work.

GIN-SAW TESTS

Tests of the effects of reducing gin-saw diameters by repeated sharpenings brought out that saws cut down one-sixteenth inch below the factory standard of 12 inches had 20 percent less ginning capacity and turned out 7 pounds less lint per bale than full-diameter saws in either brush or air-blast gins.

Comparative tests of saws to determine the effects of variations in pitch and fineness of the teeth brought significant results. Twelve-inch saws with from 280 to 300 straight teeth did the best work, ginning 8 percent faster and turning out 10 pounds more lint per bale in some cases. Straight teeth performed better than roached teeth in most instances, and equally well in others. Increased pitch for any given shape and fineness showed some improvement, but no combinations of shape, fineness, and pitch was found which showed all the advantages exhibited by these three features separately.

LOW-COST DRYING

Public Patent No. 2078309 was issued on April 27, 1937, on an airline cleaner-drier system developed at the cotton-ginning laboratories. The system is applicable to several thousand small gins, is economical, and may use various sources of heat, such as steam and gas-engine exhaust.

The previous designs of vertical tower driers, developed and patented by the Bureau, were further simplified and reduced in cost. Low-tower forms of this installation were made under Bureau supervision at two key locations in Louisiana and Mississippi, and others are under way.

Engineering developments in utilization of heat from Diesel engine exhaust and cooling water have involved Bureau consultation on nine major installations of drying systems. Field tests and observations were used to verify the Bureau estimates and calculations. By the use of this source of heat the cost of drying a bale of seed cotton has been reduced in some instances to less than 10 cents.

AIR-BLAST PRESSURES

Tests were made on commercial air-blast gins in further verification of nozzle pressure effects upon power, sample quality, and ginning capacity. Approximately 12 inches of pressure, measured on a water gage, appeared best. In January 1937, the Bureau released to cotton ginners' publications the details of its development of an effective fan inlet control for air-blast pressure. Because of this widespread publicity, patent application to cover this device was not deemed necessary.

TESTS OF BRUSH CYLINDERS

Tests of brush cylinders disclosed that defective brushes are responsible for losses in ginning time and in value of lint. Poor brushes may lower the grade value as much as 67 cents per bale, and require 10 percent more time for ginning, as compared with good brushes.

Tests were also conducted to determine setting and speed effects on brush-cylinder operation. Full meshing of the brush bristles to the depth of the gin-saw teeth produced best results. Reasonable increase or decrease in brush speed from the manufacturers' standard tip speed of 6,666 linear feet per minute made little difference in rate or quality of ginning.

SMALL GIN FOR COTTON BREEDERS

A small saw gin for the use of cotton breeders was developed by the laboratory during the year and three of them were manufactured. They were tested on various sizes of seed-cotton lots to determine uniformity and to compare their performance with commercial gin stands. Complete working drawings and construction details covering these small units are being prepared.

SMALLER PIPING SAVES POWER

The ginning laboratories have been advocating smaller piping, better fan control, and other improvements to reduce power consumption at cotton gins. Manufacturers and ginners are rapidly adopting the laboratory recommendations. Results of partially completed fan and piping studies begun last year warrant completion of the series. Thus far a high-efficiency fan and a standard type C, 18-blade gin fan in connection with two separators, and also a Rembert fan, have been tested with four piping sizes and three principal handling conditions. The piping was tested with air only, then with cotton being conveyed, and finally with static nondelivery or blanked-off conditions.

These incomplete tests indicate possibilities of saving power and confirm the recommendations. Piping in gins has commonly been 12-inch or larger. The tests showed that for equal 4,000-feet-velocity suction in a 50-foot wagon suction, a saving of 4.8 horsepower was effected by using 10-inch suction pipe and 11-inch discharge pipe. Reduction in pipe size reduced the fan speed 150 revolutions per minute in this case and the power from 17.6 to 12.8 horsepower. Further reduction to 10.5 horsepower was found possible by use of the high-efficiency fan in combination with an improved separator.

In other tests employing 150 feet of representative cotton-house piping, the power savings possible with reduction to optimum sizes of piping were evident. Thus a conventional 13-inch pipe required 24.9 horsepower, a 12-inch pipe 21.3 horsepower, an 11-inch pipe 20.2 horsepower, and a 10-inch pipe 15.8 horsepower. As all had the same suction force of 4,500 feet velocity for this long run of piping, and as the 10-inch pipe handled enough cotton to more than supply a 4–80 ginning outfit, the change to the 10-inch size in a present-day gin would save 9.1 horsepower. In these same series of tests, the use of a good separator further reduced the power approximately 20 percent for the 10-inch and 30 percent for the 11-inch piping. Likewise, the substitution of a Rembert fan for the standard fan and good separator reduced the power requirement to 10.7 horsepower as compared to 13.6 horsepower, and in addition eliminated from 3 to 5 horsepower needed to drive the separator.

EXTENSION WORK

Severeal special extension programs affecting groups of States were continued from last year. Land-drainage maintenance work was carried on in Delaware, Maryland, Ohio, Indiana, Illinois, Iowa, Missouri, and Kentucky in counties served by C. C. C. drainage camps under the technical direction of the Division of Drainage of the Bureau.

Selections were made of plans for farmhouses and other farm buildings for the Northeastern States, through organized cooperation between the Division of Structures of this Bureau, the Extension Service, and the Offices of Cooperative Extension Work in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, and West Virginia. A plan book was prepared and arrangements made for its distribution in the region. These plans were selected by representatives of the colleges as being best adapted for general use in the region. Special plans adapted to different States will be furnished as before by individual colleges. It is expected that this book will be kept on hand by county and home demonstration agents, lumber dealers, and others for use by farmers as a ready reference in selecting the best types of buildings for their needs. The detailed plans for erecting the buildings will be available from the extension service of each college at low cost. A similar plan service has been in operation in the Middle West for 3 years.

Twice during the year extension specialists in cotton ginning improvement work were brought together at the United States Department of Agriculture cotton-ginning and fiber laboratories at Stoneville, Miss., for conference and to attend schools for technical training in the newer developments in cotton ginning. The courses were conducted jointly by engineers of the Bureau and cotton-quality specialists of the Division of Cotton Marketing of the Bureau of

Agricultural Economics. Specialists attending came from Alabama, Arkansas, Georgia, Louisiana, Mississippi, Missouri, North Carolina, Oklahoma, South Carolina, Tennessee, and Texas. Extension field work for improvement in harvesting, handling, and ginning cotton is in progress in all the principal cotton-producing States.

An increase of more than 126,000 rural electric customers during 1936 emphasized the need for expanding extension activities to assist farmers in problems of wiring and equipping for satisfactory use of the power now available. Concurrently with the line construction these customers will expend millions of dollars on wiring and equipment. An average annual consumption of 1,000 kilowatt-hours per customer is desired for sound financing of each line. Much of this energy must be used for income-producing purposes if electricity is to become widely available on farms. Judicious planning for the purchase, installation, and use of home equipment is equally important.

This situation requires that extension agents be supplied with adequate technical information. Mistakes in initial expenditures made by new rural line customers are financially burdensome and cannot be corrected for years. To assist State extension workers to prepare literature suited to the local needs, the Bureau extension agricultural engineer prepared two comprehensive reference lists of current public and industrial extension publications applicable directly to rural electrification problems and practices.

The following summary of engineering activities performed by county agricultural agents in 1936 indicates the nature and scope of the extension activities in which the Bureau takes part:

Engineering practices producing farm improvements in irrigation, drainage, and land clearing were reported for 37,563 farms, affecting 1,431,190 acres, with an estimated service value to farmers of $5,063,952.

Aid in the selection of better types of farm machinery and in improving efficiency in the use of machines was reported for 77,982 farms. More than 42,000 farmers were trained at meetings in adjustment and repair work on more than 95,000 machines. The agents' estimates of savings to farmers effected through this work totaled $1,476,896.

Plans furnished through extension offices were used in the construction of 84,978 buildings on 68,872 farms. Of these buildings 5,203 were dwellings. Dwellings remodeled according to plans furnished numbered 12,655. There were 67,099 farm buildings remodeled, repaired, or painted on 51,941 farms following the advice of county agents. The value of extension advice and plans on farm building work accomplished was reported as $5,537,110.

Advice and assistance were given by extension agents on electric installations on 124,786 farms, which checks closely with the statistical record reported by the power companies and indicates the close attention being given to rural electrification. The value of this service and savings to farmers was estimated by the agents at $3,079,052, a conservative figure in view of the approximately $60,000,000 initial investment by the 124,786 farmers for lines, wiring, and equipment. In addition, planning assistance was reported on more than 80,000 units of other home equipment, such as water systems, heating systems, and appliances for 53,000 farms.

The researches, publications, and building plans of the Bureau have been widely used by extension workers.

INFORMATION AND PUBLICATIONS

In addition to the preparation of material for printed publications, the Bureau supplied many articles for distribution by the press and radio services of the Department, and Bureau employees took part in a number of radio broadcasts. In all, 35 press releases were issued on Bureau work and 46 statements were used in radio talks. More than 60 articles were contributed to technical and trade journals.

A mimeographed monthly news letter is issued to employees of the Bureau. The Bureau contributes regularly to a department entitled "What's New in Agricultural Engineering," in the Journal of the American Society of Agricultural Engineers.

Since July 1, 1936, the Bureau, in some cases in cooperation with other bureaus, has issued the following publications: Laying Out Fields for Tractor Plowing (revised), Farmers' Bulletin 1045; Border Method of Irrigation (revised), Farmers' Bulletin 1243; Rammed Earth Walls for Buildings (revised), Farmers' Bulletin 1500; Harvesting with Combines, Farmers' Bulletin 1761; Use of Concrete on the Farm, Farmers' Bulletin 1772; Care and Maintenance of

Cotton Gin Saws and Ribs, Circular 393; Machine Placement of Fertilizers for Snap Beans in Florida, Circular 399; Oil Burners for Home Heating, Circular 406; Equipment for Applying Dust Fungicides to Seed Grain, Circular 415; Use of Soil Moisture and Fruit Growth Records for Checking Irrigation Practices in Citrus Orchards, Circular 426; Plans of Farm Buildings for Northeastern States, Miscellaneous Publication 278; Flow of Water Around 180-Degree Bends, Technical Bulletin 526; Protection of Apples and Pears in Transit from the Pacific Northwest During the Winter Months, Technical Bulletin 550.

The following bulletins prepared in cooperation with the Bureau were issued by other agencies: Mutual Irrigation Companies in California and Utah, Farm Credit Administration Bulletin 8; An Improved Trackside Storage for Potatoes, University of Maine, College of Agriculture, Extension Service, Bulletin 237; An Improved Type of Farm Potato Storage, University of Maine, College of Agriculture, Extension Service, Bulletin 238.

LIBRARY

The Bureau library, which is a branch of the Department library, now contains approximately 4,500 books and 10,000 pamphlets, and receives regularly some 265 periodicals. More than 7,000 catalog cards were added during the year. To meet the growing demands for library service, a new permanent assistant was added to the staff.

CATALOGS

A catalog of papers written by members of the Bureau staff for outside publication has been added to the collection. It contains approximately 500 manuscripts and is growing steadily.

It is now possible to give more attention to the periodical and pamphlet catalog which is much used because of the large amount of material not indexed in the printed catalogs.

The library also maintains a catalog of current press releases and mimeographed speeches and radio talks of the Department of Agriculture.

BIBLIOGRAPHIES

Current literature in Agricultural Engineering, the monthly publication of the Bureau library, has a circulation of 500 copies, including Bureau personnel, technical libraries in this country, some foreign libraries and other institutions, and certain individuals interested in this field. Two important bibliographies were issued this year—Land Drainage, 1900–36, and Agricultural Engineering.

SERVICE WORK

The work for the Bureau of Biological Survey in constructing migratory waterfowl refuges was continued along the lines described in previous reports. Fifty projects were active during the year. Of these 3 were completed, 15 under construction, 23 in the planning stage, and 9 reconnaissance surveys were made.

Engineering appraisal of lands in the lower Mississippi River Valley in connection with the flood-control work of the War Department was continued in cooperation with other agencies of the Department of Agriculture. A large party has been in the field during the year making appraisal of about 1,200,000 acres of land.

A study of the water rights of the Western States has been made for the Soil Conservation Service, the purpose being to determine the effects of such rights on the contacts of the Service with the public in those States.

The studies of the utilization of the waters of Rio Grande in Texas, New Mexico, and Colorado for the National Resources Committee were completed and a report for limited distribution prepared. A total of more than 2,000,000 acres was mapped and classified with respect to water requirements.

The Bureau's Division of Plans and Service prepares working plans of buildings and equipment for other bureaus and offices of the Department. This work usually includes review and checking of materials and shop drawings, and, upon request, advice during the progress of construction work. In certain cases inspection and supervision have been provided during construction.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - Price 5 cents

REPORT OF THE CHIEF OF THE BUREAU OF ANIMAL INDUSTRY, 1937

United States Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., September 20, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I present herewith the report of the Bureau of Animal Industry for the fiscal year ended June 30, 1937.

Sincerely yours,

J. R. Mohler, *Chief.*

CONTENTS

ACTIVITIES OF NOTEWORTHY PROMINENCE

The work of the Bureau of Animal Industry dealt during the last year, as formerly, with the prevention, control, and eradication of animal diseases and parasites; the administration of various Federal livestock laws; inspection work; and research. The continued freedom of the United States from many of the more serious livestock diseases that prevail in foreign countries is gratifying. Prominent among these are foot-and-mouth disease, rinderpest, contagious pleuropneumonia, and surra.

The Bureau has continued to concentrate its efforts on several major activities, notably the suppression of tuberculosis, Bang's disease, and tick fever. Meanwhile it continued its customary regulatory and research functions as well as undertaking several new projects.

TUBERCULOSIS ERADICATION

In cooperation with all the States, the Bureau has continued its active campaign against bovine tuberculosis. In this project, now in its twentieth year, official veterinarians applied approximately 13,750,000 tuberculin tests, disclosing 0.7 percent of reactors. The total number of tuberculin tests was materially less than those in recent years, largely because of the practical completion of active eradication work in the majority of States and the fact that subsequent activities has consisted largely in retesting. Good national policy requires the periodic retesting of herds in order to maintain the advances made thus far against bovine tuberculosis.

The method that has brought about a reduction in the extent of the disease to less than 0.5 percent in 44 States is capable of accomplishing complete eradica-

tion. When retesting is conducted actively and thoroughly there are excellent prospects of reducing tuberculosis to the vanishing point.

BANG'S DISEASE

The Bureau has now completed the third year of an active campaign against Bang's disease in cooperation with the States. In the past this malady has been especially injurious because of its characteristic of causing abortions, thus interfering materially with breeding work and herd improvement. Of more than 8,000,000 cattle to which agglutination tests were applied during the year, about 5 percent were reactors and about 9 percent of these reactors were purebred registered cattle.

Supplementing its field activities for the suppression of Bang's disease, the Bureau has continued its scientific researches. The most promising present method of conferring protection against the disease is vaccination during calfhood. In a series of experiments involving 115 vaccinated and control animals, about 89 percent of the former resisted the disease as compared with 27 percent of the controls. These encouraging results, obtained under controlled experimental conditions, indicate a rather high degree of effectiveness. Calfhood vaccination is consequently being given a practical trial in several hundred infected herds in various parts of the country.

TICK ERADICATION

Good progress occurred in the systematic campaign against cattle-fever ticks in those areas of the South still infested with this injurious parasite. Provisions of the Emergency Relief Appropriation Act made possible the employment of additional workers whose number reached a peak of 1,879 during the year. Under the direction of regular employees, the augmented personnel was able to make more than 28,000,000 other inspections or dippings of ticky animals for which more than 13,000 dipping vats were used in the course of eradication work.

This activity further reduced the quarantine area, which is now only about one-twentieth of its size when eradication work was undertaken in 1906. Public sentiment in behalf of tick eradication continues to be favorable with prospects of further reduction of the ticky area each year until complete eradication is accomplished.

MEAT INSPECTION

As in previous years, Federal meat inspection was conducted on a large scale, more than 71,000,000 animals and their products receiving inspection. This service has proved to be of value in diverse fields, as well as for its primary purpose of insuring that products from inspected establishments are clean and wholesome.

Because of their voluminous nature, meat-inspection records from year to year have been a valuable index to trends of production, imports, and exports, and the extent of diseases affecting food animals. The total federally inspected slaughter in the fiscal year 1937, for instance, exceeded that of the previous year by more than 9,000,000 animals, or approximately 15 percent. The year's records likewise disclose material increases in canned, fresh, and cured pork inspected for importation, but decreases in fresh and canned beef, oleo products, and edible tallow. The quantity of canned pork received from Poland, Hungary, the Netherlands, Denmark, Estonia, Germany, and Argentina was approximately four times as great as in 1936. It is noteworthy that the total quantities of meats, exclusive of rendered edible fats, inspected for importation exceeded those of the previous year by about 23,500,000 pounds notwithstanding the simultaneous large increase in inspected domestic slaughter.

Meat-inspection records showed also a continuance of the downward trend in bovine tuberculosis, mentioned in last year's report. Condemnations of cattle carcasses for this malady were less than two-thirds as many as in 1936, and of parts of carcasses about half as many.

SERUM-MARKETING AGREEMENT

Plans to stabilize the commercial production of anti-hog-cholera serum and hog-cholera virus culminated during the year in a marketing agreement and order executed by the Secretary of Agriculture and published as Bureau of

Animal Industry Order 361. This action resulted from a series of conferences between leaders of the serum-virus industry and officials of the Department of Agriculture. The agreement and order provide for a control agency composed of 12 members of the serum-virus industry. Handlers of serum and virus are required to file with the Secretary of Agriculture, and also the control agency, lists of selling prices, including terms of sale and discounts. The purpose of the plan, under which 130 handlers were operating at the end of the fiscal year, is to bring about greater stability in the production of anti-hog-cholera serum and hog-cholera virus so that adequate quantities at reasonable prices may be available at all times for the prevention of hog cholera.

REGIONAL LABORATORIES ESTABLISHED

An augmented research program for dealing with major agricultural problems of regional nature was authorized during the year by the Bankhead-Jones Act. Accordingly, in cooperation with the Office of Experiment Stations, plans were formulated to establish a regional swine-breeding laboratory at Ames, Iowa, an animal-health laboratory at Auburn, Ala., and a range sheep-breeding laboratory at Dubois, Idaho.

The swine-breeding laboratory will deal principally with the improvement of hogs through the application of scientific breeding methods. It will be the coordinating unit and headquarters for the administration of a regional program in which at least 13 Corn Belt experiment stations will participate.

The animal-health laboratory will undertake the solution of major problems affecting the health of domestic animals and poultry in 13 Southern States. Projects already formulated deal with the control of Johne's disease of cattle and coccidiosis of livestock, including poultry.

The sheep laboratory is to be devoted to the development of more uniform, adaptable, and productive strains through the application of improved breeding methods. The laboratory will coordinate a research program in which the experiment stations of 12 Western States are to participate.

At the close of the year plans for much of the cooperative research work at the three laboratories were well advanced.

ANIMAL BREEDING AND MEAT RESEARCH

For many years livestock producers have sought improved means of producing animals that are efficient producers of high-quality meat. This year's research, as heretofore, points to progeny testing as a sound basis for selecting breeding stock. Outward appearance of animals is a less valuable indication of breeding quality, as the following typical example illustrates.

Two Hereford bulls, rather closely related and of apparently equal quality, were bred to beef cows of similar breeding. The calves of one of the bulls made more rapid gains and their carcasses had higher dressing percentages than did the calves of the other bull. When the rib cuts of the carcasses were roasted in a similar manner, the superiority observed in the growth of the calves of the first bull was again present in the form of more tender meat. Experimental work with other breeds and species of animals likewise has shown that differences in the breeding value of animals became apparent only after their offspring were tested. Hence the most promising means of identifying superior breeding animals is on the basis of performance or progeny tests through the offspring they produce.

Other factors already established as having material influence on meat quality include age of animals at time of slaughter, feeds used in developing and fattening, and methods of handling and storing the carcasses until used.

PUREBRED LIVESTOCK IMPORTATIONS

In connection with changes within the livestock industry, the administration by the Department of paragraph 1606 of the Tariff Act of 1930 is a valuable means of determining the numbers and kinds of purebred animals imported. Such animals are admitted to the United States duty free by certificates issued by the Department under the provisions of the act mentioned. During the year a total of 15,704 purebred animals were imported. Of these, 11,418 were cattle, 2,365 sheep, 983 dogs, and 792 horses. Swine, goats, and cats constituted the remainder. The total number of purebred animals imported was slightly greater than that of the preceding year.

Of the cattle importation, Holstein-Friesians, Herefords, Ayrshires, and Jerseys were introduced in largest numbers, there being more than 1,000 of each of these breeds. Of the sheep, the principal breeds were Suffolk, Southdown, Shropshire, and Hampshire. Of the horses, the breeds introduced in largest number were the Belgian, Clydesdale, Percheron, and Thoroughbred.

PERSONNEL

At the end of the year the Bureau rolls showed 4,012 regular employees of all grades and designations in Washington, D. C., and in the field, as compared with 4,161 at the beginning of the year. There was thus a net reduction of 149 in the total number of regular employees. Additions consisted of 424 new appointments, 19 transfers from other bureaus or departments, and 4 reinstatements, a total of 447. Separations consisted of 77 resignations, 33 deaths, 16 transfers to other bureaus or departments, 2 removals for cause, and 66 retirements under the provisions of the amended Retirement Act of May 29, 1930. Other separations, principally of agents, unskilled laborers, and seasonal and temporary employees, numbered 402, a total of 596.

In addition to regular employees, there were at the beginning of the year 2,550 emergency employees of various grades and designations serving in various activities, principally campaigns against bovine tuberculosis and Bang's disease. During the year there was an increase of 295 in the number of emergency employees.

VETERINARY EDUCATION

During the year 283 students graduated from accredited veterinary colleges, a decrease of 16 compared with the preceding year. The total enrollment was 2,307, an increase of 104.

There are 10 accredited veterinary colleges in the United States, the number being unchanged from last year. The number of foreign recognized veterinary colleges also remains unchanged at 13.

PUBLICATIONS AND EXHIBITS

Publications prepared by the Bureau and printed by the Government during the year included 56 new and revised documents. These related chiefly to the production of livestock, prevention and control of diseases, results of scientific research, and administrative matters. In addition, Bureau employees contributed 196 manuscripts to periodicals published outside the Department.

As in previous years, the Bureau furnished the Press Service and Radio Service with articles, news items, and other material of public interest for distribution to the press and for broadcasting. Employees of the Bureau likewise participated in radio broadcasts from Washington, D. C., and field stations.

The Bureau also continued to cooperate with the Department's Division of Exhibits in furnishing subject matter for exhibits to be displayed at expositions, fairs, and other public gatherings. Besides aiding in the construction of 13 new or revised exhibits, the Bureau prepared 4 others, largely of scientific nature, for special occasions. It participated also in the preparation of numerous charts, maps, lantern slides, and related pictorial material for which there is large demand from educational institutions and the public. Exhibits on Bureau activities were shown at 38 expositions, fairs, and conventions besides being lent for numerous other purposes.

The research and regulatory work of the various branches of the Bureau is presented more fully in the following pages.

ANIMAL DISEASE STATION

Under the supervision of W. E. Cotton, the Animal Disease Station has continued its independent researches on communicable diseases of animals and, as in past years, has furnished facilities and help to other research divisions of the Bureau in conducting their investigations, particularly those involving the use of large animals. It has also cooperated with several State universities and experiment stations in animal-disease investigations. Its independent investigations for a large portion of the year were confined to tuberculosis, brucellosis of cattle and swine, and vesicular stomatitis of cattle and horses, but near the end of the year the investigations of mastitis and range paralysis of poultry were transferred to it.

BANG'S DISEASE

In last year's report, mention was made of an experiment in vaccination in which 8 of 10 animals vaccinated during calfhood completely resisted *Brucella abortus* infection that caused all the 10 unvaccinated controls to become infected and to abort. To gain further information as to the effect of vaccination and the exposure given during their first pregnancies on their subsequent breeding efficiency, all the 20 animals, principals and controls, were again bred. Their second pregnancies terminated within the year. During their second gestation period both groups were kept in separate stables and yards and subjected to only such exposure as might occur through the association of infected and noninfected animals. The 10 vaccinated heifers produced 11 vigorous calves, 1 animal giving birth to twins. At the time of calving, one of these heifers had both her uterus and udder infected with *Br. abortus* and another her udder only. These two animals, during the first year of the experiment, had given birth to weak calves and their uteri and udders had been infected as a result of *Br. abortus* exposure. On the termination of their second pregnancies, the remaining eight principals were free from *Br. abortus*. The 10 controls gave birth to 8 vigorous and 2 weak calves. At the time of calving, the uteri of three controls were infected with *Br. abortus* and the udders of these three and of five others were likewise infected. The first pregnancies of all the controls terminated in abortion, and *Br. abortus* was present in the uteri of all the animals and in the colostrum of all but one.

Another calfhood-vaccination experiment, in which 14 principals and 9 controls were used, was nearly completed during the year. All these 23 animals, during their first pregnancies, were given *Br. abortus* conjunctival exposure. The 14 principals gave birth to 13 vigorous calves and 1 weak one. The uterine exudates and colostrum of two principals that gave birth to vigorous calves were shown to contain *Br. abortus*. However, in the remaining 12 principals, the absence of the infectious agent was indicated by results of guinea pig inoculations with these substances. Of the nine controls, five aborted and *Br. abortus* was present in their uteri and colostrum. Three produced vigorous calves and one a weak calf. *Br. abortus* was present in the colostrum of one that produced a vigorous calf. Therefore, in this experiment, 86 percent of the principals completely resisted exposure that infected 67 percent of the controls.

The project dealing with field trials of calfhood vaccination against Bang's disease, conducted jointly by the Tuberculosis Eradication Division and the Animal Disease Station, was continued with encouraging results. This method is now being tried in about 278 herds in each of which, at the time inaugurated, 15 percent or more of the animals reacted to the Bang's-disease agglutination test. Approximately 4,100 calves have been vaccinated. One *Br. abortus* strain, no. 19, much reduced in virulence, has alone been used in the preparation of the 6,576 doses of vaccine forwarded to Bureau inspectors located in the various States who supervise its injection and keep records of the work.

The studies made during the year of the transmissibility of infectious abortion from swine to cattle consisted in exposing lactating cows free from *Br. abortus* to swine artificially infected with *Br. abortus* of the swine type. Nine cows and one pregnant heifer, negative to the agglutination test for Bang's disease, were confined in a yard of about one-quarter acre with eight pregnant sows artificially infected with porcine *Br. abortus*. These cows were regularly milked in the infected environment throughout the experiment. Six other pregnant sows, negative to the agglutination test for infectious abortion, were also placed in the enclosure to act as controls on the *Br. abortus* exposure supplied by the infected sows. Frequent agglutination tests were made of the blood serum of the sows, and at semimonthly intervals agglutination tests were made of that of the cows.

Guinea pigs were also injected with the milk obtained from the cows at these times. During the 10 months that the cattle and swine had been together at the end of the fiscal year, guinea pig inoculation results failed to indicate the presence of *Br. abortus* in the milk of any of the cows although at some time during the course of the experiment all the cows reacted, to some degree, to the agglutination test. Except in one case, the agglutination titer did not exceed 1 to 50. One cow, however, on a single test reacted in a titer of 1 to 400, but a month later this animal again gave negative results to the test. That the cattle were given *Br. abortus* exposure of considerable severity was evidenced by the fact that all six contact sows used in the experiment acquired

agglutination reactions of high titer. The results of this experiment, like those of previous similar ones, show that cattle may react to the agglutination test for brief periods because of exposure to *Br. abortus* infected swine. They also indicate that the danger of cattle becoming more than transiently infected with the porcine type of *Br. abortus* through natural exposure to infected swine is slight.

This station, in cooperation with the Division of Virus-Serum Control, tested 266 samples of abortion vaccine prepared by various commercial biological firms, the vaccines being examined for purity, density, and virulence. Of the samples tested, 176 were found to be satisfactory, but 90 were contaminated, nonviable, or not produced from proper *Br. abortus* strains. These results called for the condemnation of the vaccines represented by the latter group.

Agglutination tests to the number of 12,517 were made of cattle during the year in connection with the Federal program for combating Bang's disease, and in addition, 3,741 tests were made of cattle in Government-owned herds.

A considerable amount of check testing of *Br. abortus* antigens used in the Federal Bang's disease program and of blood-serum samples was done during the year. *Br. abortus* strains suitable for antigen preparation were supplied to field laboratories, and cultures of a *Br. abortus* strain of low virulence, for use in vaccine production, were furnished biological firms.

The cooperative abortion-disease projects begun in 1929 with eight State universities and experiment stations were continued. Some of these studies, the results of which have either been published or prepared for publication, have yielded information of value in combating the affection.

TUBERCULOSIS

In connection with an outbreak of tuberculosis in the herd of the Bureau of Dairy Industry Experiment Station, Beltsville, Md., it was stated in the preceding report that 25 of the tuberculin-reacting cattle from this herd were transferred to the former Experiment Station at Bethesda, Md., in order to study the virulence of the infecting organism. These cattle were slaughtered, a few at a time, during the last fiscal year. Considering the length of time these animals had been infected, the character of the lesions, as a whole, indicated that the infecting organisms were of only moderate virulence.

A tuberculin test made of the equine animals at the Bureau of Dairy Industry Experiment Station, Beltsville, during the last fiscal year showed three reactors to tuberculin. These three animals, one mule and two horses, were transferred to the Animal Disease Station. The mule was slaughtered, and a few small, densely calcified lesions were found in the bronchial lymph glands and one in a lung. Inoculations from these lesions failed to produce tuberculosis in laboratory animals, indicating that the infection, if tuberculosis, had been overcome.

Following the report of W. H. Feldman, of the Mayo Foundation in Minnesota, with regard to the finding of avian tubercle bacilli in 24 of 30 swine condemned for generalized tuberculosis in an abattoir in southeastern Minnesota, specimens of lesions from 36 swine condemned for generalized tuberculosis in abattoirs in five of the North Central States were studied with respect to the type of infecting tubercle bacillus. In 21 of these the lesions were found to be due to the avian type of tubercle bacillus and in 15 to the bovine type. Both avian and bovine types of infection were found in each of the five States. These findings are of especial interest from two standpoints. They show (1) that the avian tubercle bacillus is capable of causing progressive, generalized tuberculosis in a small percentage of swine affected with this organism, and (2) that foci of infection with the bovine tubercle bacillus still exist in each of these States. The latter shows the need for follow-up testing in modified accredited areas. Examination of this small number of specimens of swine tuberculosis indicated a difference in the macroscopic appearance of lesions due to avian and bovine tubercle bacilli respectively. In the bovine type of lesions necrosis was invariably present, whereas in the avian type necrosis was observed in only one of the 21 specimens. Further investigation of this point is planned.

Studies of the subcutaneous tuberculosis type of tuberculin reactors, commonly called skin-lesion reactors, were continued. One such case was recently found in a herd at this station, which, on the primary test, gave a suspicious reaction to mammalian tuberculin and on a test made 3 months later gave a slight reaction to avian tuberculin and a well-marked reaction to mammalian tuberculin. When the primary test was made one small lesion was found under the skin of the right front knee, and when the second test was made two additional lesions were

observed above the older lesion. Six weeks later, three additional lesions were observed a short distance above the three older ones. The results of the tuberculin tests in this animal indicate that sensitization to tuberculin continues as long as new lesions are forming.

Thirty-three samples of commercial tuberculins prepared for veterinary use were tested for purity and potency. Several of these products were low in potency. These results show the necessity for the continuance of periodic tests of these products.

VESICULAR STOMATITIS

It was noted in last year's report that the two types of virus of vesicular stomatitis, New Jersey and Indiana, that had been kept alive by uninterrupted passage through guinea pigs, showed evidence of becoming reduced in virulence. Early in the present year the New Jersey virus was replaced by a virulent strain of the same type. The Indiana virus, continually passaged through guinea pigs, when tested on cattle near the end of the year produced characteristic lesions of vesicular stomatitis.

As in past years, a supply of guinea pigs made immune to the Indiana or New Jersey types of the virus was kept on hand for differential diagnosis in case of an outbreak of any of the exanthematous diseases of livestock.

VESICULAR EXANTHEMA OF SWINE

A paper was published on experimental vesicular exanthema of swine showing that this disease is not highly contagious and, in this respect, resembles vesicular stomatitis more closely than foot-and-mouth disease.

No outbreaks of vesicular exanthema of swine were reported during the fiscal year.

MOVING OF STATION TO BELTSVILLE COMPLETED

The abandonment of the Experiment Station at Bethesda was completed early in the year when the remaining animals quartered there were moved to the Animal Disease Station at Beltsville. Further work was done during the year in improving the station at Beltsville by increasing stabling facilities, yards, and pastures, extending water and electric lines, and putting additional land into cultivation.

ANIMAL HUSBANDRY AND ANIMAL NUTRITION DIVISIONS

Animal-husbandry investigations were conducted by the Animal Husbandry Division, under the direction of Hugh C. McPhee, chief, and by the Animal Nutrition Division, under the direction of Paul E. Howe, chief. The work of the former consisted chiefly of research in livestock breeding and management and that of the latter chiefly of research in livestock nutrition and feeding, including the chemistry of feeds and animal products. Because of the closely related nature of these fields of study, the work of the two divisions is reported jointly.

During the year the Animal Husbandry Division continued to cooperate, through three extension representatives, with the Extension Service and State extension workers in the establishment and furtherance of livestock projects.

BREEDING AND FEEDING INVESTIGATIONS WITH SMALL ANIMALS

In genetics investigations with inbred lines of guinea pigs and their hybrids, the various lines showed rather striking differences as measured by body weight, but body composition in terms of percentage of fat, water, ash, and protein showed little variation. The largest variation noted was in percentage of fat. The variation observed in other body constituents was largely a result of this, since the percentage of other body constituents was practically constant when determined on a fat-free basis. A striking sex difference was observed in percentage of fat, females having the higher percentage. Seasonal differences in fat content were also noted, animals slaughtered during the summer months having a higher fat content than those killed during the winter months. Separate chemical analyses were made of the hide, organs, and blood, and of the carcass exclusive of these. Variability in composition was lowest for the blood and highest for the hide. The organs were relatively uniform in composition. No striking differences were observed in the calcium, phosphorus, or catalase

content of the blood, either from seasonal effects or as a result of genetic differences.

Analysis was made of inherited eye defects that appeared in one line of the guinea pig colony. The defective line, which arose from a normal male and four of his sisters, was characterized by various types of eye defects, such as rotated eyeballs, opaque eyes, microphthalmia, or complete absence of eyeballs. The defects are clearly hereditary, but the exact mode of inheritance was not determined. A lethal action of the defective condition was indicated by a higher percentage of mummified fetuses in the defective line as well as by a higher death rate among the affected animals. The defective line was lost because of the very high sterility of the breeding animals of this strain.

The general increase in vigor of the inbred lines noted in last year's report has been maintained, offering further evidence that some of the former decline in vigor may have been due to environmental causes.

In studies of the inheritance of intelligence and temperament in domestic animals, dogs are being used as experimental animals. They have shown a wide variation in ability to form the conditioned reflexes of lying down and getting up to whistle signals. Individual dogs, however, have been consistent in their performances, as is indicated by reliability coefficients of 0.95 ± 0.32 for lying down and 0.97 ± 0.43 for getting up. Results to date indicate that the animals differ considerably in such factors as willingness, timidity, and alertness and also in the interest they show in sheep in trials of herding ability.

At least in the puppy stages the body form and hair type of the Hungarian Puli in general appear to be recessive to those of the German Shepherd, Chow, Scottish Terrier, and Border Collie. Segregation for color has been obtained in crosses of Puli × Chow and of purebred Puli.

In studies on the measurement of the nutritive value of grasses, guinea pigs and rabbits were fed on diets made up wholly or in part of bluegrass. In a number of respects, guinea pigs were the more satisfactory experimental animals for this test, but neither are able to digest the crude fiber of these rations to the extent that cattle and sheep can. Protein supplements added to the bluegrass diet were no more valuable than a supplement of sugar for growth of either rabbits or guinea pigs. In order to obtain adequate nutrient intake for growth, it was necessary to furnish at least 20 percent of the diet as a concentrate feed, such as corn, sugar, or similar feed. Under such conditions, good growth was obtained in the experimental animals.

MEAT INVESTIGATIONS

Meat investigations included both independent work and cooperative studies with the Bureaus of Agricultural Economics and Home Economics and 10 State experiment stations.

The first experiment of a comparative study of the meat of yearling cattle, one group being fed a typical Corn Belt ration and another group a typical Cotton Belt ration, was completed during the year in cooperation with the South Carolina Agricultural Experiment Station. The first group of cattle was fed corn with alfalfa hay, and the other, cottonseed meal with cottonseed hulls, each steer in both groups being fed individually for a feed-lot gain of approximately 200 pounds. The meat from the latter group tended to have darker colored lean and, after being roasted, a less desirable aroma, although it was more tender than the meat from the former group. Percentages of separable fat and ratios of meat to bone were practically the same for the two rations.

In cooperation with the North Carolina Agricultural Experiment Station, yearling and 2-year-old steers, of the same breeding and with the same feeding and management, were compared to determine the effects of age on the characteristics of the dressed carcasses and meats. The older cattle had a higher dressing percentage, although average carcass grade was the same for both. The raw lean meat of the yearlings was lighter in color, and the rib cuts had a higher average percentage of eye muscle and lower percentages of separable fat and edible portion. Roasted rib cuts from the yearlings had slightly more aroma and flavor of lean, were more tender, less juicy, and the juice was less rich. The yearling cattle made the more rapid and economical feed-lot gains.

Results formerly reported on the higher percentages of ham, loin, and bacon produced by Danish Landrace hogs than by representatives of the Bureau's strains of Poland China and Duroc-Jersey hogs were substantiated by additional data. In yield of ham the differences were not large enough to be statistically significant, nor was the difference in yield of bacon of the Poland China hogs.

In yield of bacon of the Duroc-Jersey hogs, however, and in yield of loin of both domestic breeds, the differences were sufficiently large to be significantly in favor of the Landrace. Study of the dressing-percentage data showed that the Landrace hogs produced a slightly lower proportion of chilled carcass than either of the other breeds, but neither of the differences was significant.

A preliminary analysis of data was made on certain hog-carcass measurements to determine their significance as indexes of the yield of different cuts. This analysis showed that average thickness of side, average width of carcass, and volume of side (represented by length of body times depth of side, times thickness of side), were only moderately good indexes of percentage of trimmed bacon. Length and depth of body and average thickness of back fat were poor indexes. These results indicate that factors such as length and depth of body, and fatness as indicated by thickness of back fat, often regarded as useful indexes of bacon yield, are not especially valuable for that purpose, at least when considered separately.

A 4-year study with the North Carolina Agricultural Experiment Station on methods of feeding soybeans to pigs for the production of firm pork was completed during the year. Pigs with initial weights of approximately 60 pounds were fed rations containing 30, 40, and 50 percent of soybeans, with yellow corn, tankage, alfalfa leaf meal, and a mineral mixture. From approximately 100 to 225 pounds of weight, all pigs were fed the same ration of yellow corn 75 percent, cottonseed meal 13 percent, tankage 5 percent, alfalfa leaf meal 5 percent, and mineral mixture 2 percent. With only a few exceptions, the chilled carcasses of all were of satisfactory firmness.

In first-year tests on the effects of subfreezing temperatures on fresh and cured meat, pork loins held for 7 days at 20° F. and then thawed and roasted were as palatable as their pair mates, from the other side of the hog, stored at 34° for the same period. Likewise there was no important difference between pork loins stored 29 days and their pair mates stored 7 days, both at 20°. However, loins stored at 20° for 181 days were dry, tough, strong in flavor, and undesirable in comparison with their mates stored for 34 days under similar conditions. At 20° shrinkage in weight ranged from 3.3 percent for 7 days of storage to 14.1 percent for 181 days of storage.

A study was made of the carcasses of 38 hothouse lambs, including both purebred and cross-bred lambs, produced at the United States Morgan Horse Farm, Middlebury, Vt. With an average chilled weight of 28.4 pounds, these carcasses yielded, on the average, 25.6 percent of separable fat, 55.0 percent of lean, and 80.6 percent of total edible portion. Previous unpublished work has indicated that with lambs produced under the usual, less intensive conditions such high percentages are found only in carcasses weighing approximately 40 pounds or more. Thus hothouse lamb carcasses possess a given degree of fatness, proportion of lean meat, and ratio of meat to bone at a much lighter weight than do the carcasses of lambs produced under less intensive conditions. Leg roasts of the hothouse lambs were judged as tender although lacking somewhat in juiciness. The lean and fat were rated as "moderately pronounced" in flavor, and in quality of juice the roasted meat was "slightly rich."

Paired legs weighing approximately 4 to 6 pounds, from Choice and Good grade lambs, were cured in sweet pickle (6 pounds of salt, 3 pounds of sugar, and 3 ounces of saltpeter) with a salinometer reading of 70°, for periods ranging from 10 to 30 days at a temperature of approximately 38°. The cured legs were then smoked at about 110° for 18 to 20 hours, after which one leg of each pair was analyzed for salt content, portions of individual muscles being used for samples. The other leg was roasted and judged for palatability. Legs with the muscles or lean meat averaging between 4 and 5 percent of salt content, on a wet basis, were most desirable to the judges. This concentration was generally attained when the legs had been in cure approximately 4 days for each pound of weight. Salt appeared rather evenly distributed throughout the leg muscles except in the 10-day cure when it failed to penetrate completely portions of the muscles nearest the femur bone.

A tentative method for determining the juice content of cooked meat was developed, 50-gram samples of ground meat being used in a hydraulic press. A maximum pressure of 10,000 pounds for 15 minutes is applied to the sample in the test cylinder of 2¼ inches diameter. The method is regarded as an advance in meat-research technique. However, further work is required to establish more definitely the relationship between the juice-content values thus

determined mechanically and those recorded by human judges. The study thus far has indicated that, on standing after cooking, the meat undergoes some change which is believed to have a bearing on the relationship between judges' scores and values determined mechanically. The major objective of this work is to develop accurate, precise laboratory technique which will at least supplement and if possible replace human judgment in measuring differences in the juice content of meat.

BEEF AND DUAL-PURPOSE CATTLE INVESTIGATIONS

Beef and dual-purpose cattle investigations were conducted at 5 Federal and 10 cooperating State experiment stations.

BREEDING INVESTIGATIONS

In record-of-performance studies at the National Agricultural Research Center, certain body measurements indicated rather definitely the performance which may be expected of steers of the same weight in future rate and efficiency of gain and carcass quality. Of these, one of the best proved to be height at withers. Length of body showed an even closer relationship to efficiency and rate of gain but a much lower correlation with carcass quality. These results as yet have only experimental application but offer considerable promise of eventual practical use.

From these measurement data a method of estimating the approximate weight of beef and dual-purpose cattle through the use of heart-girth measurements was developed. It was found that the weight of an animal could be estimated within about 30 pounds by the use of its heart-girth measurement, thus affording a means of checking weights fairly accurately when scales are not available. Tables listing the weights at the various heart-girth measurements are available.

The average annual production per cow in the Milking Shorthorn herd at the National Agricultural Research Center was 7,850 pounds of milk and 310 pounds of butterfat, and at the United States Morgan Horse Farm it was 7,700 pounds of milk and 300 pounds of butterfat. Eighteen 2-year-old heifers at Beltsville and eight at Middlebury qualified for the Shorthorn register of merit. They had an average production practically equal to the average of the herd, indicating that at maturity they should produce more milk than their dams. These heifers gained an average of 160 pounds per head from time of calving to time of completing the test, indicating also possible improved beef-production qualities.

At the Iberia Livestock Experiment Farm, Jeanerette, La., in cooperation with the Louisiana Agricultural Experiment Station, in a cross-breeding experiment with Brahman, Africander, and Aberdeen Angus cattle, cross-bred calves in general continued to make more rapid growth than the purebreds. It also appears that a predominance of blood of a strictly beef-bred animal such as the Aberdeen Angus is desirable in the cross-bred having Brahman blood.

In record-of-performance studies at Jeanerette there is some indication that the cross-bred calves use feed more efficiently but do not produce such high-quality carcasses at a slaughter weight of 750 pounds as the purebred Aberdeen Angus.

Observations on the effect of environmental conditions on Brahman × Aberdeen Angus and Aberdeen Angus cattle at Jeanerette indicate that first-cross Brahman × Angus cattle utilize more time grazing during daylight hours of summer than either quarter-bred Angus × Brahman (one-fourth Brahman and three-fourths Angus) or purebred Angus. Observations on the changes in respiratory rate and body temperatures in the sun and in the shade indicate that half-bred Brahman × Angus are the least affected by high temperatures in the sun and return to normal after extreme heat more quickly than either the quarter-bred Angus × Brahman or purebred Aberdeen Angus cattle.

In record-of-performance studies with Hereford cattle at the United States Range Livestock Experiment Station, Miles City, Mont., in cooperation with the Montana Agricultural Experiment Station, to develop superior strains of Hereford cattle adapted to the northern Great Plains, tests of the progeny of two rather closely related herd sires of supposedly equal quality were continued. In a 322-day fattening experiment, 294 days of which consisted of individual feeding on wheat and alfalfa hay, steer calves sired by one of these bulls were significantly superior to those sired by the other bull in rate of gain,

dressing percent, and quality of meat. There was no significant difference in efficiency of gains. Heifers sired by the two bulls were wintered on a medium plane of nutrition and carried on native range the subsequent summer. There was no significant difference in their scores as calves or yearlings, in total gain, or in average final weight as yearling heifers.

A study was made at the Chinsegut Hill Sanctuary, Brookville, Fla., in cooperation with the Florida Agricultural Experiment Station to develop strains of grade cattle of improved beef qualities better suited for range-cattle production in that section. In this study effort has been made to develop cattle with the polled characteristic and of a uniform color. Red Polled bulls were crossed with native horned cows of various colors. Observations on the offspring indicate that the grade heifers are significantly superior to their native dams in beef quality, conformation, and type. About 80 percent of all calves were red, although 60 percent of the calves out of black cows were black. In polled characteristic, 20 percent of the male calves were polled, 45 percent had small scurs, and 35 percent had loose horns. None had well-developed horns. All the heifers were entirely polled or had only very small scurs.

Breeding investigations with Red Polled and Milking Shorthorn cattle at Valentine, Nebr., in cooperation with the Nebraska Agricultural Experiment Station, indicate that cows freshening in the spring returned more profit above feed costs than those freshening in the fall, at least in this section.

FEEDING INVESTIGATIONS

In a steer-fattening experiment at Big Spring, Tex., in cooperation with the Bureau of Plant Industry and the Texas Agricultural Experiment Station, steers full-fed ground milo heads made greater gains, dressed a higher percentage, and were significantly higher in carcass grade than steers fed only limited quantities. The full-fed steers were also more profitable, selling at approximately $1 per hundredweight higher and returning approximately $7 more per head than the limited-fed steers.

At Spur, Tex., in cooperation with the Texas Agricultural Experiment Station, a study to determine the carotene requirement of fattening beef steers indicated that night blindness was the first general indication of vitamin A deficiency to appear when the supply of carotene was insufficient. After vitamin A deficiency occurred, it was found that 275 to 385 micrograms of carotene in alfalfa hay per 100 pounds of live weight daily was too low to maintain health and normal gain. There was evidence that 900 micrograms of carotene per 100 pounds of live weight is enough to carry steers through a long fattening period without marked indication of vitamin A deficiency, although on this level night blindness did not entirely disappear. Eye and nerve tissues from steers that showed disturbed vision are being examined for the presence of pathological changes.

Mineral-deficiency investigations in cooperation with the Texas Agricultural Experiment Station were begun in southern Texas in the spring of 1937. Analyses of forage samples and cattle observations made thus far indicate that a rather pronounced phosphorous deficiency exists in most of the pastures studied.

In a cooperative experiment at Sni-a-Bar Farms, Grain Valley, Mo., with the Missouri Agricultural Experiment Station, a study was made to determine the value of substituting blackstrap molasses for part of the corn in a ration consisting of shelled corn (8 parts) and cottonseed meal (1 part) for suckling calves and for fattening weanling calves. It was found that, previous to weaning, the calves fed the molasses were slower in cleaning up their feed, made less gain, and entered the fattening period in poorer condition, but at a lower feed cost. For fattening it was found that replacing half of the corn of the shell-corn and cottonseed-meal ration with blackstrap molasses produced lighter weight cattle with appreciably less finish and lower selling price on the market. The advisability of making this replacement depends upon the relative price of corn and molasses and the market value of the increased finish.

In steer-fattening experiments at Tifton, Ga., in cooperation with the Georgia Experiment Station and the Georgia Coastal Plain Experiment Station, steers fattened by grazing corn and velvetbeans did not gain so rapidly or produce so much finish as those fed a ration of snapped corn, velvetbeans, and peanut hay

in dry lot, and the cost per 100 pounds of gain was considerably greater. In another test, the feeding of cottonseed meal with snapped corn and peanut hay proved to be more profitable than the use of peanut meal with these feeds. A ration of ground ear corn, ground velvetbeans, and peanut hay produced slightly greater gains than did rations in which 30 and 50 percent of the corn were replaced with molasses.

Wintering experiments with yearling heifers were carried on at the United States Range Livestock Experiment Station, Miles City, Mont., in cooperation with the Montana Agricultural Experiment Station. A ration of 4.24 pounds of alfalfa hay and 15.75 pounds of mixed Russian-thistles and straw reduced winter feed costs $5.95 per head over a 102-day period compared with the cost of a ration of 19.8 pounds of alfalfa hay, when mixed-thistle hay was valued at $2.50 and alfalfa hay at $10 per ton. Heifers fed the former ration made average winter gains of 13.7 pounds and combined winter and summer gains of 81.4 pounds, whereas those on alfalfa hay alone made average winter gains of 72.7 pounds and combined winter and summer gains of 119.1 pounds. Heifers wintered on alfalfa hay, Russian-thistles and straw weighed on the average 32.3 pounds less per head at the close of the subsequent summer-grazing season than those wintered on a full feed of alfalfa hay, but feed and range cost per 100 pounds of gain was only $8.06 compared with $10.50 for the latter.

The Bureau cooperated with the Florida Agricultural Experiment Station at Brooksville, Fla., in 2 years' feeding trials comparing silages of sugarcane, Napier grass, and sorghum as the principal roughage for wintering calves, with cottonseed meal and cowpea hay completing the rations. The sorghum silage was somewhat superior to both sugarcane silage and Napier grass silage. The younger calves were not able to utilize the more fibrous sugarcane and Napier silages so efficiently.

Mature native breeding cows wintered satisfactorily on all three silages. Sugarcane silage was the most economical, although cows fed sorghum silage gained 109 pounds per head, whereas those fed sugarcane silage and Napier grass silage gained only 85 and 71 pounds, respectively.

Cottonseed meal was superior to tankage as a concentrate for wintering yearling and 2-year-old steers with a roughage ration of 32 pounds of sugarcane silage and 3 pounds of cowpea hay. Those fed cottonseed meal were in uniformly better flesh at the end of the 112-day wintering period. Tankage was less palatable than cottonseed meal, and the steers seemed to tire of it after the first 6 weeks.

MANAGEMENT INVESTIGATIONS

In an experiment to determine the value of feeding grain to steers on pasture for the entire period or for the last 69 days of a 125-day grazing period, the results of 3 years' work at the Ardmore Field Station, Ardmore, S. Dak., proved the former practice to be unprofitable. The steers fed grain during the entire period made significantly greater gains but they did not dress significantly higher nor grade higher, either as slaughter cattle or in the carcass, than the steers fed grain for the limited period, and their feed cost was considerably higher.

In a comparison of alternate and continuous grazing at this station, a 3-year test showed that alternate grazing did not produce significantly greater gains or higher grade in feeder steers. Steers produced under both systems sold for essentially the same price per hundredweight. Tests indicate also that under normal conditions at this station approximately 17 acres, whether grazed continuously or alternately, will furnish sufficient forage for a yearling steer during the winter and for a 2-year-old the subsequent summer, provided small quantities of feed are used to supplement the range during adverse seasonal conditions or when the vegetation is covered with snow.

In a continued experiment at the United States Range Livestock Experiment Station, in cooperation with the Montana Agricultural Experiment Station, breeding cows wintered 141 days on reserved native creek bottoms and upland browse range, supplemented by 88 pounds of cottonseed cake, sustained somewhat heavier winter weight losses than cows fed a winter supplement of 765 pounds of alfalfa hay. However, they were stronger and more active at the end of the winter than the latter animals. There was no significant difference in birth and weaning weights of their calves, but under the first system of management the cost per 100 pounds of calf produced was $2.81, whereas under the second system it was $3.38.

In a single trial to compare the relative profit derived from selling steers as yearling feeders or carrying them to be sold as 2-year-olds, no advantage was found in carrying the steers the additional year before marketing.

Calves from cows that were grazed on overstocked, moderately stocked, and lightly stocked pastures weighed 313.8, 372, and 361 pounds, respectively, at weaning time. When subsequently wintered on alfalfa hay for a 100-day period, the three groups of calves required successively increased quantities of hay for each 100 pounds of gain produced. Calves from the cows on the overgrazed range produced larger and more economical gains from weaning time until the close of the winter feeding season but never fully recovered the difference in weaning weight.

Pasture experiments at Tifton, Ga., in cooperation with the Bureau of Plant Industry, the Georgia Experiment Station, and the Georgia Coastal Plain Experiment Station, show that a mixture of Dallis grass, carpet grass, common lespedeza, and white clover is probably the best mixture for lowland pastures of the district. Centipede grass is unsatisfactory as a pasture grass at the Tifton station. A mixture of Bermuda grass and common lespedeza appears to be the best for the upland pastures of the district. Fertilizer experiments indicate that phosphorus is the most deficient element, and applications of high-phosphorus fertilizers to pastures produced increased cattle gains.

At Summerville, S. C., in cooperation with the South Carolina Experiment Station, an experiment to determine the value of temporary pastures in wintering steers showed that the grazing of winter rye pasture reduced the quantity of silage required for the winter feeding period by 735 pounds per head and the rye-pastured steers gained about 13 pounds more per head.

In fertilizer experiments at this station with permanent pastures, the yield of beef was highest when the pastures were treated with 2,000 pounds of lime per acre every third year and 250 pounds of superphosphate per acre annually. The lowest return was from native pasture with no fertilization.

SHEEP, GOAT, AND ANIMAL-FIBER INVESTIGATIONS

Investigations in sheep and goat husbandry and in animal-fiber technology were conducted at 6 Federal stations and at 17 farms and laboratories of cooperating State experiment stations.

SHEEP-BREEDING INVESTIGATIONS

In cooperation with the Idaho Agricultural Experiment Station, 16 Lincoln ewes were inseminated at Moscow, Idaho, with semen obtained at the United States Sheep Experiment Station, Dubois, Idaho, from a Lincoln ram of outstanding merit as a sire. Three of these ewes produced a total of 4 healthy lambs from these artificial inseminations. Some of the semen was as much as 44 hours old when used in successfully effecting pregnancy. As a result of this preliminary study of the possibilities of long-distance transportation of semen for artificial insemination of sheep, techniques have been developed which should result in higher percentages of successful conception in future work. Results thus far indicate the possibility of increasing greatly the usefulness of especially meritorious rams by using this method with selected ewes at far distant locations.

In cooperation with the Missouri Agricultural Experiment Station at Columbia, Mo., a study of the pituitary glands of ewes in various phases of heat and pregnancy was conducted. Pituitary bodies from 60 ewes slaughtered at different phases of the reproductive cycle were studied by numerous techniques. Nine morphologically different types of cells from the glandular lobe were identified and placed in six fundamentally different groups. Two of these groups show changes which can be interpreted as secretory and appear to be correlated with the phase of reproduction. This study, which is being continued, is designed to develop techniques for evaluating the reproductive capacity of ewes in advance, thereby saving the time and expense required by actual test of breeding and resultant lambing.

At the Dubois station, Suffolk rams were more efficient than Hampshire rams as sires of Prime and Choice slaughter lambs from Rambouillet and Corriedale ewes under range conditions. Weaning weights averaged 82 pounds for the 267 lambs sired by Suffolk rams and 77 pounds for the 240 lambs sired by Hampshire rams. Fifty-one percent of the Suffolk-sired lambs graded Choice or Prime in slaughter grade, whereas only 34 percent of the Hampshire-sired lambs graded

as high. In slaughter grade, the former averaged high Good and the latter only Good.

A strain of Hampshire sheep of very outstanding merit in mutton production and trueness to breed type has been developed at the Beltsville station through the use of superior breeding stock from one of England's leading flocks of Hampshires. This strain possesses outstanding excellence in plumpness of leg of mutton, approaching the excellence of some of the best Southdowns in this characteristic.

The Bureau is developing at Middlebury, Vt., a strain of Shropshire sheep outstanding in trueness to breed type and high degree of uniformity in mutton and wool characteristics. At this station also, the Southdale strain of sheep is being developed through mating of Southdown × Corriedale ewes with Southdown × Corriedale rams and similar interbreeding of their offspring. About one-fourth of the yearling Southdales of the second generation show a preponderance of Southdown characteristics in type, mutton form, and character of wool, and approximately one-fourth show a preponderance of Corriedale characteristics. The remainder show a well-balanced blend of the Southdown and Corriedale characteristics and are close rivals of the excellent Shropshires with which they are being compared. Since such qualities as general type, mutton form, and character of wool depend on a multiplicity of hereditary factors, it should be possible to develop from these superior animals breeding lines that will perpetuate the desirable combinations at a high level of uniformity. A strain of sheep that combines excellent mutton and wool characteristics is especially valuable in New England and similar territory.

The Bureau is cooperating at Quincy, Fla., with the Florida Agricultural Experiment Station in the development of a strain of sheep that will combine the mutton and wool qualities of Columbia sheep with the adaptability of the native sheep to thrive under the conditions of climate, feed, and parasitism that prevail in northern Florida and other territory of the southeastern Gulf coast region. This is to be accomplished by breeding native Florida ewes with Columbia rams and mating the resulting grade ewes with the grade rams or by a series of backcrosses followed by inbreeding. The first generation of offspring shows considerable improvement over the native sheep. The fleeces of the first-cross yearling ewes averaged 9.2 pounds of unscoured wool, the yearling native ewes in the same flock averaged 6.5, and the yearling Columbia ewes 12.1 pounds. In leg of mutton the first-cross yearling ewes averaged Good, the yearling native ewes top Medium, and the yearling Columbia ewes top Good.

In breeding studies with Karakul sheep at Beltsville a grading system for Karakul lambskin fur was developed in cooperation with the Bureau of Biological Survey. It provides for classifying the fur into 4 sizes of curl: Small, medium, large, and broad, each of these being further divided into 10 grades of desirability from 1, superior, to 10, most inferior. Under this system, of the 95 Karakul skins produced this year 24.2 percent classed as small, 50.5 as medium, 15.8 as large, and 9.5 percent as broad. In desirability, those classed as small averaged 5.8 in grade, those of the medium class 7.2, those of the large class 7.7, and those of the broad class 7.4. The average desirability grade for all was 6.9. Only 9.5 percent of the skins graded 4 or higher, these being in the group having the small curl.

From a breeding standpoint, the skins of the 41 purebred Karakul lambs produced during the year graded an average of 6.4 in desirability; those of the 21 Karakul × Corriedale lambs, averaging 89 percent pure Karakul, graded an average of 7.9; and those of 33 Karakul × Blackfaced Highland lambs, averaging 85 percent pure Karakul, graded an average of 7.0.

Studies are being conducted to develop more adequate means of measuring variations in animal form, growth, carcass value, efficiency of feed utilization, and similar characters of importance to the animal breeder and livestock geneticist. Data on 67 Southdown, 62 Shropshire, and 68 Hampshire lambs were analyzed to determine the correlation between body measurements taken at 2, 4, 6, and 8 months and those taken at 12 months of age. In general measurements at each successive age showed higher correlation than the earlier measurements. The correlations at even the early ages appeared sufficiently high to indicate that measurements at these ages have some value as measures of mature animal form.

A study of flock records at Beltsville showed that there is a definite relation between birth weight and weights at 3, 6, and 12 months of age. The coefficients of correlation with birth weight were less with each succeeding

age but were sufficiently high to indicate that birth weight is valuable as an indicator of growth during the first year. Compared with the lightest one-third of all lambs born, the heaviest one-third at birth weighed 9 pounds more at 3 months and 10.5 pounds more at 12 months. Earlier lambs also tend to make faster growth than later lambs, the earliest one-third born weighing 4.6 pounds more at 3 months and 3.1 pounds more at 12 months of age than the latest one-third born. Single lambs weighed 7.4 pounds more than twins at 3 months and 5 pounds more at 1 year of age.

The ability of lambs to survive to 3 months of age is not affected by the type of birth, for twins survive equally as well as singles. Late lambs seem to have somewhat less chance of survival than earlier lambs. The lambs lighter at birth have less chance of survival than heavier ones.

SHEEP-FEEDING INVESTIGATIONS

At the Beltsville station, results from the feeding of lambs individually showed a difference in rate of gain as great as 38 percent between the slowest and fastest gaining lambs fed similar rations under the same environment. In efficiency of gain, there was a variation of 36 percent between the least and the most efficient lambs in terms of total digestible nutrients per pound of gain. Such differences emphasize the importance of determining the individual feed intake and gain when conducting intensive sheep-feeding and nutrition studies. They also reveal the large opportunities that may exist for improving strains of sheep for efficiency in feed utilization.

At the Belle Fourche Field Station, Newell, S. Dak., in cooperation with the Bureau of Plant Industry and the South Dakota Agricultural Experiment Station, the value, for sheep, of feeds grown in the locality of the Belle Fourche irrigation project was studied. The most profitable ration consisted of corn, cottonseed cake, pressed beet pulp, and alfalfa hay. This ration produced an average daily gain of 0.35 pound per lamb and a profit of $1.01 per lamb above feed cost. The least efficient ration consisted of corn and Sudan grass hay, which produced a daily gain of only 0.17 pound and a loss of $0.68 per lamb. A ration of corn, pressed beet pulp, and alfalfa hay produced a daily gain of 0.35 pound and a profit of $0.39 per lamb. A ration of corn and alfalfa hay was compared with one containing corn, monocalcium phosphate, and alfalfa hay. No advantage was shown for the monocalcium phosphate. This finding indicates that there is no phosphate deficiency in a ration of corn and alfalfa hay when the hay is grown in that locality.

SHEEP-MANAGEMENT INVESTIGATIONS

At Beltsville, a crop of soybeans, cut and fed green in the barn, yielded 767 sheep days of feed per acre, approximately twice as much as was obtained from grazing similar good soybean pasture.

Studies in the management of sheep on the intermountain ranges, conducted at Dubois, Idaho, in cooperation with the Forest Service, showed great benefits to the sheep and to the range forage from so managing the grazing program as to protect the forage in the early stages of growth. Crested wheatgrass is proving to be valuable for reseeding abandoned farm lands in range sheep-grazing areas. The destruction of sagebrush by controlled burning is receiving study as a means of increasing the quantity and availability of good sheep forage.

In cooperation with the Forest Service and the Montana Agricultural Experiment Station, a study of the best methods of managing sheep grazing on the ranges of the northern Great Plains is being conducted at Miles City, Mont. An area of 4,100 acres has been fenced into sectors to furnish five definite experimental grazing areas and one holding area for replacement sheep. Five degrees of stocking are being compared, one area furnishing 0.10 forage acre of grazing per sheep per month, a second 0.15, a third 0.20, a fourth 0.25, and a fifth area 0.30. Results of this study will not be available until data covering several years can be studied and correlated. Approximately 85 different species of plants were grazed by the sheep. In every sector they even grazed on the fresher parts of the spiny cactus.

MILK-GOAT BREEDING INVESTIGATIONS

The germ-plasm survey to determine the status of milk-goat breeding in the United States revealed that only two research institutions in the United States

are now conducting investigations on milk-goat breeding. Both institutions, the New Mexico Agricultural Experiment Station and the United States Department of Agriculture, have brought about great improvement in their herds by grading up from common doe stock with purebred bucks of milk breeds. The results indicate great potentialities for milk-goat improvement by the application of improved breeding methods. The survey revealed that future milk-goat improvement must come largely through the efforts of breeders themselves. Practices that should be of general benefit include (1) the keeping of more complete records of milk and butterfat production, fertility, and fecundity; (2) the development of a more extensive record-of-performance program that will identify the better breeding stock; (3) the more extensive use of proved sires; and (4) the development of a better spirit of cooperation among breeders.

Breeding studies are being conducted at Beltsville with Toggenburg and Saanen goats to develop strains of goats with improved capacity for the production of milk of relatively high butterfat content. As the average doe has a tendency to breed only during the cool fall and winter months, an effort is being made to segregate does that will breed during the warm months of late spring and summer so as to improve the distribution of the goats' milk supply throughout the year. As such does are identified they will be used in that phase of the study designed to develop strains that may be depended upon to breed out of the regular season.

INVESTIGATIONS OF GOATS' MILK

In a study of the chemical composition and the nutritive properties of goats' milk to establish the differences between the proteins of cows' milk and of goats' milk, pure preparations of albumin, lactoglobulin, and casein were made from goats' colostrum and goats' milk and analyses of these proteins are now in process. Similar preparations of albumin were made for analysis of goats' blood for comparison with albumin preparation made from goats' milk.

In connection with studies on the biological significance of the various organic fat acids and the importance of unsaturated fat acids in nutrition, attention was given to the separation and identification of unsaturated fat acids in animal fats. Hexadecanoic acid was found in small quantities in goats'-milk fat, in egg-yolk fat, and in the body fat of the rat. A study of the chemical nature of the acids isolated from the various sources showed that they were the same and corresponded to ordinary palmitoleic acid.

INVESTIGATIONS OF WOOL AND OTHER ANIMAL FIBERS

A system has been developed at Beltsville for rapidly determining the fineness and uniformity of fineness of wool fibers through the use of equipment for making thin cross sections of wool fibers. This equipment consists of a microprojector and a new device called a comparator. The latter has recently been developed in the Bureau's animal-fiber laboratory. This improved method in measuring fineness and variability in wool is being used to study the variability in the fleece from different locations on the sheep, as well as in different parts of the same staple. Differences in various parts of the same staple were found in many instances to be as great as those found in the different locations in the body of the fleece. In order to broaden the application of the cross-sectional method for measuring fineness and cross-sectional variability in wool, a graphic method has been developed for computing rapidly and accurately the diameter and standard deviation direct from the projected images of the cross sections. Through the use of this graphic method a much larger number of samples can be measured than by the use of the older, slower methods.

Wool-scouring studies at Beltsville, show that Corriedale fleeces produced at that station yielded, on the average, 49.52 percent of dry, clean wool, whereas Corriedale fleeces produced at Dubois, Idaho, yielded 35.62 percent. The weight of clean wool in these fleeces, adjusted to 365 days of growth, averaged 5.12 pounds for the Beltsville Corriedales and 3.82 pounds for the Dubois Corriedales. The percentage of clean wool in the Shropshire fleeces grown at Beltsville average 53.65 and in Shropshire fleeces grown at Middlebury, Vt., 55.26 percent, or nearly the same. However, the average weight of clean wool in these Shropshire fleeces, when adjusted to 365 days of growth, was 4.29 pounds for the Beltsville fleeces and 3.65 for the Middlebury fleeces. These results indicate the appreciable effect of environmental conditions and feed on the growth and yield of wool.

The weight of fleeces from Southdales and Shropshires grown at Middlebury, adjusted to 365 days of growth and compared before scouring, averaged 0.68 pound more per fleece for the Southdales. But on a clean-wool basis the Shropshires produced 0.12 pound more than the Southdales, the weights being 3.53 and 3.65 pounds, respectively.

SWINE INVESTIGATIONS

Swine of the Chester White, Danish Landrace, Danish Yorkshire, Duroc-Jersey, and Poland China breeds were used at Beltsville, in studies involving different systems of breeding, economy of production, and progeny testing.

BREEDING INVESTIGATIONS

A study to compare the pork-producing efficiency of pigs of Danish Landrace and Danish Yorkshire breeding was continued, with variations in size of litter farrowed, number of pigs weaned, and rate and economy of gain again covering a wide range. A summary of averages, however, again makes possible tentative comparisons. Pigs in this study, unless otherwise noted, were self-fed a standard ration in dry lot from 72 days of age for the spring pigs and 70 days of age for the fall pigs to weights of approximately 225 pounds. In several cases fall litters were used in feeding trials that were not comparable with the ones reported here. The results that follow accordingly were derived from trials considered comparable.

Sixteen spring litters and thirteen fall litters of Landrace pigs averaged 9.6 pigs per litter at farrowing and 5.2 pigs at weaning. The spring pigs gained at the rate of 1.10 pounds daily and required an average of 368 pounds of feed per 100 pounds of gain, whereas the fall pigs gained 1.31 pounds daily and required an average of 356 pounds of feed per 100 pounds of gain. The range between low- and high-feed requirements for the spring pigs was 113 pounds of feed and for the fall pigs was 59 pounds. The lowest feed requirement for any one group of spring pigs was 334 pounds of feed per 100 pounds of gain and for any one group of fall pigs 335 pounds.

Five litters of the Poland China×Landrace cross, three spring and two fall litters, averaged 7.8 pigs farrowed per litter and 3.8 pigs weaned. The spring pigs gained 1.37 pounds daily and required 369 pounds of feed per 100 pounds of gain, and one litter of fall pigs fed for slaughter gained 1.68 pounds daily with a feed requirement of 367 pounds.

Twelve backcross litters, four spring and eight fall litters, produced by mating first-cross Poland China×Landrace sows to Poland China boars, averaged 8.5 pigs farrowed and 6.4 pigs weaned. The spring pigs gained at the rate of 1.34 pounds daily and required 357 pounds of feed per 100 pounds of gain, whereas the fall pigs gained at the rate of 1.52 pounds daily and required 359 pounds of feed.

One Danish Yorkshire sow mated to a Landrace boar produced a fall litter of 12 pigs and weaned 9. This litter gained 1.49 pounds, per pig, daily and required 361 pounds of feed for 100 pounds of gain.

One Landrace×Yorkshire sow mated to a Landrace boar for a fall litter farrowed 10 pigs and weaned 7. This litter gained 1.40 pounds, per pig, daily, and required 354 pounds of feed per 100 pounds of gain.

Three Danish Yorkshire sows, mated to the Duroc-Jersey boar used in the Duroc-Jersey×Landrace cross, averaged 12.3 pigs farrowed and 9.7 weaned. Pigs in the two spring litters gained an average of 1.39 pounds daily and required 336 pounds of feed per 100 pounds of gain.

Eight litters of Duroc-Jersey pigs, three spring-farrowed and five fall-farrowed, sired by a boar used also in crosses with Landrace sows, averaged 10.5 pigs farrowed and 6.6 weaned. Pigs in the spring litters gained 1.18 pounds daily and required 377 pounds of feed per 100 pounds of gain.

Five Poland China litters sired by boars of the same bloodlines as those used in crosses with Landrace sows averaged 7.2 pigs farrowed and 3.8 weaned. Three litters of spring pigs gained at the rate of 1.32 pounds per pig daily and required 381 pounds of feed per 100 pounds of gain.

Eight litters of Danish Yorkshire pigs were farrowed, five in the spring and three in the fall. An average of 12 pigs were farrowed per litter and 7 weaned. The spring pigs gained at the rate of 1.16 pounds daily and required 368 pounds of feed per 100 pounds of gain compared with 1.29 pounds gain and 384 pounds of feed for the fall pigs.

22605—37——3

Five litters of the Duroc-Jersey × Landrace cross averaged 10.8 pigs farrowed and 6 weaned. The spring pigs gained 1.34 pounds daily and required, on the average, 363 pounds of feed per 100 pounds of gain. The fall pigs gained 1.56 pounds daily and required 351 pounds of feed per 100 pounds of gain.

Six backcross litters, produced by mating first-cross Duroc-Jersey × Landrace sows to a Duroc-Jersey boar, averaged 7.5 pigs farrowed and 3.2 weaned. The spring pigs averaged 1.05 pounds of daily gain and required 352 pounds of feed per 100 pounds of gain. The fall pigs gained 1.71 pounds daily and required 368 pounds of feed per 100 pounds of gain.

At the United States Range Livestock Experiment Station in cooperation with the Montana Agricultural Experiment Station, matings of purebred Landrace hogs were compared with a mating of a purebred Landrace boar to a solid-black Hampshire sow, the latter animal having occurred in a herd of belted Hampshires. Five purebred Landrace fall litters averaged 8.3 pigs at birth and 5.4 pigs at weaning. The Landrace×solid-black Hampshire litter produced 7 pigs at birth and at weaning. The Landrace pigs were self-fed from approximately 4½ months of age to a final weight of approximately 225 pounds. They made an average daily gain of 1.46 pounds and required 435 pounds of concentrates and 2.8 pounds of alfalfa hay per 100 pounds of gain. The cross-bred pigs were fed in a separate lot and were 3 months of age at the beginning of the feeding period. They gained 1.60 pounds daily and required 392 pounds of concentrates and 6.5 pounds of alfalfa hay per 100 pounds of gain.

When comparisons are made between the various breeds and their cross-bred progeny, it is evident that the first-generation crosses made higher daily gains than their respective parent strains. A similar situation holds for the backcrosses although, in general, their average daily gains were not so high as those of their respective cross-bred parents. In feed requirements per 100 pounds of gain, the differences in favor of the crosses were not so marked as were those for daily gains. The limited data on the spring and fall litters indicate that the fall litters made slightly better gains.

A preliminary study of color inheritance made on the crosses between domestic breeds and the Landrace indicated that the white color of the Landrace is almost completely dominant over both the red of the Duroc-Jersey and the black of the Poland China. In all cases the first crosses showed some black skin spotting. In crosses between the Landrace and the solid-black Hampshires, there was less color uniformity, apparently owing to greater genetic differences among the Hampshires than among either the Duroc-Jerseys or Poland Chinas. Crosses of this type resulted in animals with various color markings, such as black and white spotting, striping, and belting.

Matings of Poland China × Landrace cross-breeds with the Poland China resulted in the production of animals whose color resembled that of the foundation parents, as well as animals with various degrees of black and white spotting. Similar crosses involving the Duroc-Jersey likewise resulted in the recovery of both parental colors, with some animals showing various degrees of black and red spotting, and roaning.

Seven inbred Chester White litters were fed according to record-of-performance methods. The range in average daily gain for the pigs of four spring litters was from 0.65 to 1.35 pounds. Feed consumed per 100 pounds of gain ranged from 343.4 to 437.2 pounds. The three fall litters, when fed in two groups, made average daily gains of 1.18 and 1.19 pounds, per pig, with feed requirements of 405.4 and 408.4 pounds for 100 pounds of gain.

Type studies involving the small, intermediate, and large types of Poland China were continued. Fall-farrowed hogs of the three types were slaughtered on the basis of degree of finish, the small type averaging 145 pounds, the intermediate 221, and the large type 256 pounds at time of slaughter. The three types gained respectively at the rate of 0.94, 1.28, and 1.33 pounds daily from weaning to finish. The small type required approximately 12 percent more feed per unit of gain than either the intermediate or large type.

Litters fed under record-of-performance procedure were grouped according to sires. The results of these tests showed considerable variation in rate of daily gain and feed requirements per unit of gain for litters sired by the same boar, as well as for litters sired by the different boars. These results suggest the advisability of making as many matings as possible in an effort to isolate superior matings for the retention of meritorious breeding animals.

Studies conducted in cooperation with the medical school of Johns Hopkins University were made to determine the basic factors involved in the normal formation of blood. Assays made of the livers of pig fetuses for the antianemic principle showed that this substance, if present at all, is found in extremely small quantities as compared with the quantity found in the livers of adult animals. Extracts made of the livers of still-born pigs and of young animals of various ages indicate that the antianemic principle is either absent from the livers of still-born animals, or present in extremely small quantities, but appears in the livers of older animals. A study bearing on the origin and formation of the antianemic principle, together with its relation to the vitamin B complex, is now in progress. Experimental evidence thus far indicates that, at least under certain conditions, vitamin C in adequate quantities is not synthesized in the pig.

In studies on the physiology of reproduction, conducted in cooperation with the Missouri Agricultural Experiment Station, semen was collected in an artificial vagina from boars previously deprived of certain accessory organs by surgical methods. No operation, whether involving the removal of the seminal vesicles or the seminal vesicles and Cowper's glands, gave rise to any marked changes in libido or fertility 6 to 8 months thereafter. The amount of semen from unoperated boars averaged 68 to 79 g per ejaculator per 100 pounds of live weight; and from operated boars, 67.2 g per 100 pounds of live weight. In vasectomized boars the amount was only 32.1 g per 100 pounds of live weight. Chemical studies of both total and fractionated semen are now being made.

FEEDING INVESTIGATIONS

Preliminary tests were made at Beltsville in which 3-week-old pigs were given free access to skim milk or tankage, in addition to a standard ration, for 12 weeks, followed by a feeding period on a standard ration, self-fed. These tests indicate that the added protein in the early period of the pig's life contributed to greater daily gain, with a saving in feed per unit of gain.

There was completed also a preliminary study of variations in free-choice intake of the component feeds of the record-of-performance ration as a possible cause, along with breeding, of the occurrence of lameness and abnormal leg-bone development. Evidence thus far obtained indicates that this condition may be the result of faulty mineral metabolism. It has generally occurred among pigs confined and self-fed in dry lots, particularly in record-of-performance tests, at this and other experiment stations. Examination of the feed records at this station showed abnormally high consumption of corn and low consumption of the mineral and protein mixtures in many cases. Calcium intake was below normal requirements in such instances and tended to be associated with the occurrence of lameness. However, the incidence of lameness was higher among inbred pigs, suggesting that hereditary factors unfavorable to the animal's ability to assimilate calcium may be partly responsible for the condition. Further experiments are under way to study the interrelation of breeding and feeding and the incidence of lameness.

Five lots of eight pigs each were self-fed in dry lots from approximately 45 pounds of initial weight to 225 pounds of live weight on rations containing 5, 10, 15, and 20 percent of ground alfalfa hay, and a standard check ration, the nutritive ratio being the same for all. The average daily gains were 1.47, 1.62, 1.50, 1.33, and 1.47 pounds, respectively, and the feed requirements per 100 pounds of gain were 398, 394, 413, and 408, and 374 pounds, respectively.

During the year tests were conducted in cooperation with the Bureau of Dairy Industry on the feeding value of fresh whey, concentrated whey, and whey-treated grass silage for swine. Fattening hogs receiving all the fresh whey they would consume while on soybean pasture gained an average of 0.92 pound daily and required 3,636 pounds of fresh whey per 100 pounds of gain in addition to the pasture. Following the grazing period the hogs were fed in dry lot to a final weight of approximately 225 pounds on condensed whey and whey-treated grass silage. They gained at the rate of 1.05 pounds daily and required 1,699 pounds of condensed whey and 80 pounds of whey-treated grass silage for each 100 pounds of gain.

Three lots of eight pigs each were fed from 65 pounds of initial weight to an individual weight of approximately 225 pounds to compare a standard ration with rations in which corn silage or whey-treated grass silage replaced alfalfa meal. The pigs were hand-fed at the rate of 4 pounds of the ration per

100 pounds of live weight. The rate of gain was 1.30, 1.22, and 1.16 pounds and the feed required per 100 pounds of gain was 373, 393, and 404 pounds, respectively, for the lot receiving the standard ration, the one receiving the corn silage, and the one receiving the whey-treated grass silage.

MANAGEMENT INVESTIGATIONS

Studies were made at the Iberia Livestock Experiment Farm, in cooperation with the Louisiana Agricultural Experiment Station, on the effect, on subsequent performance, of weaning fall pigs at 8 and 10 weeks of age. The studies showed that there was no difference in the final weight or rate of gain of the pigs to a weight of 85 pounds. The 8-week-old pigs averaged 24.6 pounds at weaning and the 10-week-old pigs averaged 30.5 pounds. The total feed cost per pig from birth to 85 pounds of weight was practically the same for both groups.

Pasture studies conducted in cooperation with the Georgia Coastal Plain Experiment Station, Tifton, Ga., show that in the coastal-plain section a year-round system of providing suitable crops to be hogged off will furnish adequate feed from weaning to slaughter weight. In addition to the crops grazed, the hogs were fed a protein supplement and mineral mixture. This system produced well-finished hogs. The crops used were mature oats, Early White Dent corn, Grohoma sorghum and Spanish peanuts, Grohoma sorghum and soybeans, and corn and Hayseed soybeans. This method of production in sections where it is adaptable should help to spread the marketing of hogs over a greater portion of the year.

A summary of results of 5 years' work at Miles City, Mont., in cooperation with the Montana Agricultural Experiment Station, comparing the value of mature sows and gilts for the production of market pigs, shows that pigs from gilts were raised more economically to a marketable weight than were pigs from mature sows. Pigs from gilts showed to advantage in percentage of pigs raised to marketable weight, and also required less feed per pound of marketable weight for the gestation, suckling, and fattening periods. Mature sows, however, were better sucklers, as shown by the fact that their pigs averaged from 7 to 8 pounds heavier at weaning age.

HORSE AND MULE INVESTIGATIONS

Breeding, feeding, and management studies with light horses were continued at the United States Morgan Horse Farm, Middlebury, Vt. Further improvement in vigor and saddle conformation, especially in withers and top line, was attempted by the infusion of a top cross of American saddle horse blood with Morgan inheritance on several of the good producing dams at this farm. The resulting foals indicate a definite improvement in the qualities desired, and if they develop properly to maturity the females will be mated with Morgan stallions to work this improvement into the breed.

The mating of a Nonius stallion with Morgan mares produced two foals of this cross during the year. With parents of average size, the foals were slightly above the average of the farm's foals in size, as indicated by weight, size of bone, height, and girth circumference. Although these foals are large and apparently vigorous, possibly owing to the hybrid vigor expected in an outcross, and have the points of excellence indicated, they lack somewhat the quality, length of neck, and symmetrical proportions usually desired in an American saddle horse. The stamina and riding qualities of these animals will be determined in actual performance tests on maturity and, if found adequate, will in large measure determine the practical utility of this cross.

During the year the Nonius breeding stock, consisting of two stallions and four mares, were transferred from Middlebury to the station at Miles City, Mont., and a breeding program providing for the use of this top cross on grade Thoroughbred mares for the production of range saddle stock inaugurated. The small-type Nonius stallion was bred to 16 grade Thoroughbred mares and a Thoroughbred stallion to the same number of grade Thoroughbred mares.

Draft-horse breeding was continued at Miles City with a purebred Belgian stallion and purebred and grade Belgian mares. A breeding program was initiated with two bands of 18 mares, a Belgian stallion being mated to one band and a large-type Nonius to the other. A reciprocal cross will be made

each year with these bands to study the value of sires of these breeds for range-draft-horse production.

A cooperative study was initiated during the year with the Tennessee, Georgia, and Mississippi Agricultural Experiment Stations to study the problems of successful mule production. Work on the physiology-of-reproduction phase of this study was initiated at Columbia, Mo., and the United States Range Livestock Experiment Station in cooperation with the Missouri and Montana Agricultural Experiment Stations.

Preliminary results with 29 draft mares (Belgian and grade Belgian) and 15 light mares (grade Thoroughbred) indicate that most mares were in heat 5 to 7 days, with an average of 5.3 days and ranges of 1 to 27 days. The foal heat lasted usually 5 days, with an average of 5.25 days and ranges of 1 to 10 days. The interval from the last of one heat to the beginning of the next averaged 16 days with a range of 10 to 23 days. From parturition to first day of foal heat was 6 to 10 days, with an average of 8.25 days and a range of 3 to 13 days.

There was a variation in the intensity of oestrus or heat on the part of the same mare and in different mares. Mares ovulated 1 to 1½ days before the end of heat, with a range of ½ to 2 days.

The physical characteristics of the ovarian follicles were: Medium tense and variable in size (1 to 6.5 cm) with an average of 2.5 cm, first day of heat; increase in tenseness and in size (average 5 cm) to the day before ovulation; decrease in tenseness and in size (average 4 cm) just before ovulation. The ovaries of mares immediately after foaling were small and fibrous.

CERTIFICATION OF ANIMALS IMPORTED FOR BREEDING

Under the provisions of paragraph 1606 of the Tariff Act of 1930, certificates of pure breeding were issued for 16,094 breeding animals imported during the fiscal year. Following are the total importations by classes and breeds during the year:

	Number
Cattle:	
Aberdeen Angus	390
Ayrshire	1,542
Brown Swiss	3
French Canadian	23
Guernsey	168
Hereford	1,780
Highland	13
Holstein-Friesian	6,121
Jersey	1,244
Kerry	10
Red Danish	22
Shorthorn	489
South Down	3
Total	11,808
Horses:	
American Saddle	1
Arabian	6
Belgian	441
Cleve and Bay	1
Clydesdale	95
East Prussian	1
Hackney	28
Nonius	6
Percheron	90
Shetland Pony	1
Shire	6
Standardbred	4
Suffolk	35
Thoroughbred	75
Welsh Pony	2
Total	792
Sheep:	
Cheviot	25
Corriedale	1
Cotswold	57
Dorset Horn	4
Hampshire	103
Kent or Romney Marsh	1
Leicester	10
Lincoln	71
Oxford Down	41
Shropshire	114
Southdown	797
Suffolk	1,141
Total	2,365
Goats:	
Nubian	3
Saanen	2
Toggenberg	3
Total	8
Swine:	
Berkshire	34
Large Black	4
Tamworth	3
Yorkshire	82
Total	123
Cats: All breeds	15
Dogs: All breeds	983

The year was notable for an increase over the previous year of 8 percent in the importation of horses, 48 percent in the importation of sheep, and 251 percent in the importation of swine. Importation of Belgian horses continued to be large. Among the breeds of sheep there was a notable increase in the importations of Hampshires and Suffolks, and of swine, Yorkshires led in numbers.

POULTRY INVESTIGATIONS

POULTRY BREEDING

In an investigation of eggshell quality, using loss of moisture during 7 days of incubation as a criterion of shell strength and shell texture, it was shown that these two characteristics, important in the marketing and storage of eggs, were inherited.

In experiments on egg quality, hatchability was found to be affected adversely in eggs weighing more than 25 ounces to the dozen and in eggs having a relatively large quantity of total albumen. It was determined that, although the percentage of thick albumen, which is a criterion of the interior quality of the egg, is affected chiefly by inheritance, this percentage also varied according to the month during which the eggs of a given bird were laid. The percentage of thick albumen in pullet eggs became less as the season of production advanced from October to July, after which it increased rapidly. The percentage of thick albumen in proportion to total albumen in an egg was found to have no effect on the hatchability of eggs laid by White Leghorns, Rhode Island Reds, White Wyandottes, or Light Sussex.

There is a general impression among many poultrymen that cross-bred chickens will not only grow faster to broiler age and show greater viability, but that the pullets will produce more eggs than the progeny of the standard-bred parent stock. In a comparison of standard-bred White Leghorns and Rhode Island Reds with cross-bred stock obtained from the same parental strains, Leghorns and Rhode Island Reds averaged 202 eggs per bird and the cross-breds 145 eggs; there was practically no difference in average weight per egg. Furthermore, the standard-bred birds averaged less than 5 percent of broodiness, whereas the percentage of broodiness in the cross-bred pullets ranged from 25 to nearly 46. The cross-breds, however, were slightly heavier than the progeny of the standard-bred Rhode Island Reds at broiler age (10 to 12 weeks) and had higher viability.

In an experiment on sex identification of Rhode Island Red baby chicks it was demonstrated that day-old male chicks usually had no black spotting or striping in down color and the day-old female chicks usually had this black spotting or striping. The data indicated that the day-old chicks from most Rhode Island Red flocks can be sexed by this means with an accuracy of approximately 80 percent.

POULTRY INCUBATION AND PHYSIOLOGY

Incubation tests made throughout the year indicate that even when birds receive an adequate diet fortified by cod-liver oil, direct sunlight will increase the hatchability of their eggs by approximately 14 percent. Hatchability of eggs from birds receiving diets containing an inadequate protein concentrate, soybean meal, dropped to about 25 percent during the winter months and then rose to about 70 percent during spring and summer.

Abnormal incubation temperatures produced the same relative decline in hatchability of eggs of inherently high hatchability as in those of inherently low hatchability. Undesirable families of chickens, from the standpoint of hatchability, are not eliminated by abnormal temperature in the process of incubation.

Experiments with artificial insemination of poultry showed that 0.1 cc of mixed semen from several male birds placed in the uterus of the laying hen once a week will insure the fertility of about 90 percent of her eggs. The average cockerel will produce sufficient semen to serve 50 to 75 females if used daily with the technique of artificial insemination developed at the National Agricultural Research Center and if the quantity of semen used per hen is limited to 0.1 cc once each week.

POULTRY FEEDING

An analysis of data previously obtained on the effect of fattening on the physical and chemical composition of cockerels showed that birds reared on range had a higher percentage of breast muscle, leg muscle, and total edible portion than those reared in confinement. During fattening relatively large quantities of both fat and water are deposited in the adipose tissue. Con-

trary to common belief, a part of the water in the tissues is not replaced by fat during the process of fattening; as a matter of fact, the absolute quantities of both water and fat are increased. The leg muscle of both fattened and unfattened cockerels contains a considerably greater proportion of water than the other edible portions and the breast muscle contains somewhat less. Fattening increased the fat content of the breast muscle about 85 percent, of the leg muscle about 43 percent, and of the remaining edible portion about 57 percent.

For the purpose of making good meat scrap and other similar products, it was found that the materials used are relatively more important than the temperature and length of time of processing as long as the temperature does not exceed 200° F. and the time of processing 8 hours. The vitamin G content of an all-beef scrap was found not to be affected by the temperature or time of processing as long as they did not exceed these limits. Both steam-dried and spray-dried blood meal had approximately one-half the vitamin G content of a good grade of all-beef scrap made in the following proportions: 20 percent of carcass meat, 10 of livers, 10 of spleens, 10 of skulls, 15 of beef rennets, 10 of tripe trimmings, 15 of hashed pecks, and 10 percent of beef cutting scrap. When liquid stick and a mixture of blood meal and stick were used in place of the meat scrap in the diet of laying hens, there was an increase in embryonic mortality throughout the incubation period, this increase being especially noticeable during the third week of incubation.

The feeding of insoluble grit to chickens was found to have only a slight effect on the digestibility of the feed. The effect was less when an all-mash diet was fed than when southern field peas were fed. Coarse grit was slightly more effective than fine grit. The greatest improvement in digestibility was observed in the case of the fat.

It was found that a high level of calcium intake tends to affect hatchability adversely. In egg production, pullets and hens do not react alike to high and low levels of calcium intake. On the lower levels the hens lay more eggs than the pullets, but on the higher levels the pullets lay more eggs than the hens. With both, however, the percentage of embryos dying during the last 3 days of incubation increased as the level of calcium intake was increased. A method was devised for estimating the percentage of calcium required for any given rate of egg production.

In a study of the number and distribution of the component fat acids in the glycerides and phospholipids of egg yolk, as an index of nutritive value of eggs, attention was given to the composition of eggs produced by hens fed on a normal mixed grain and mill-feed ration. In addition to palmitic, stearic, and oleic acids, linoleic and other more highly unsaturated acids of the arachidonic and clupanodonic type have been identified in both the glyceride and the phospholipid fractions. The highly unsaturated acids are among those considered to be essential nutritive factors. In addition, palmitoleic acid was found in the glyceride fraction only.

TURKEY INVESTIGATIONS

A study of the trap-nest egg records of the turkey flock at Beltsville, indicates egg-laying characteristics similar to those of chickens, especially in the variation in number of eggs produced by individual hens. Some turkeys show more broodiness than others, and there are wide variations in the intensity and the persistency of egg production.

Breeding a small, compact type of turkey is in progress at this station. A number of breeding birds with the desired characteristics have been produced by selection and cross-breeding. Further crosses are being made in an effort to fix the preferred characters in several distinct families.

When young Bronze turkey hens were fasted overnight, slaughtered, dry-picked, and then air-chilled overnight, the average loss in weight was 9.55 percent; the corresponding loss for young Bronze turkey toms was 9.65 percent. Large birds of both sexes lost a smaller percentage than the smaller birds and fat birds lost less than thin birds. The loss in weight due to full-drawing averaged 14.7 percent of the dressed, chilled weight in the toms and 15.39 percent in the hens.

Incubation experiments with turkey eggs indicate that eggs incubated in a forced-draft commercial incubator, at 99½° to 100° F., may be transferred to the separate hatcher at 97° to 97.5° at any time between the twenty-first and

twenty-sixth days of incubation without affecting hatchability. Lowering the temperature in the incubator from 99¾° to 97¼° and shifting the eggs from large-end-up to a horizontal position did not show any adverse effect on hatchability when the change was made at any time from the twelfth to twenty-sixth days of incubation. However, eggs which were not turned during the first 21 days of incubation showed decreased hatchability.

NATIONAL POULTRY IMPROVEMENT PLAN

During the second year of the National Poultry Improvement Plan, 1,239 hatcherymen, whose plants have a hatching capacity of more than 52,500,000 eggs, participated in the program. These figures represent 13 percent of the hatcheries and nearly 17 percent of the estimated hatching capacity of the United States, and is an increase in capacity of 38 percent over that of last year. Hatching eggs were obtained by participating hatcheries from approximately 30,500 flock owners who followed the provisions of the plan in the selection of their 6,500,000 breeding birds.

There are 301 poultry breeders who are trap-nesting 112,202 birds in conformity with the United States record of performance provisions of the plan. Last year only 190 such breeders with a total of 66,500 birds were participating.

A marked improvement in the organization and administration of the plan was observed in each of the 41 participating States during the hatching season. The work of selecting birds and testing for pullorum disease was more efficiently and uniformly handled than in the previous year, and there were more thorough inspection and a greater degree of compliance with the provisions of the plan.

BIOCHEMIC DIVISION

The Biochemic Division, under the direction of Robert M. Chapin, chief, conducted work on hog cholera, dips, disinfectants, antiseptics, anthelmintics, certain meat products, and certain biological preparations for the detection of specific diseases.

HOG-CHOLERA INVESTIGATIONS

During the year there were produced 49,000 cc of hog-cholera virus, chiefly for the experimental preparation of vaccines, and 38,000 cc of anti-hog-cholera serum, chiefly for use by the Animal Husbandry Division. At the request of the Division of Virus-Serum Control, nine commercial serums were subjected to the official 11-pig potency test. As local service work in swine diseases, 18 farm herds were inspected and 53 swine from sick herds were examined in the laboratory of the Division's experiment station at Ames, Iowa.

Work on crystal-violet vaccine for use against hog cholera was continued. Twenty-nine lots of phosphated crystal-violet vaccine, each comprising blood from two or more pigs inoculated with virus, were completed and tested, with 100-percent success from the production viewpoint. No lot showed bacterial contamination or harmful effect on susceptible pigs, and all the 140 test pigs resisted virus injection 3 weeks later without any important reaction. Nearly half of these test pigs received vaccine doses of only 5 cc, and eight received only 3-cc doses. The formula (80 volumes of defibrinated virus blood, 10 volumes of a 3-percent solution of anhydrous dibasic sodium phosphate, and 10 volumes of a 0.5-percent solution of crystal violet) was released in April for experimental production by commercial concerns.

The vaccine appears to be rather resistant under storage. No decrease from normal potency was observed in samples incubated for 8 weeks at 37.5° C., for 2 weeks at 39.5°, or after the usual 2-week incubation at 37.5° followed by storage in a refrigerator for various periods to 10 months. In these experiments the vaccinated pigs were held for various periods to 6 months before being tested with virus. Within the stated limits, neither the age of the vaccine nor the period elapsing between vaccination and virus injection, nor both in conjunction, appeared to be important. The immunity acquired by the station pigs in this series of experiments was nearly 100-percent satisfactory.

The inhibition of the antigenic power of vaccine by passively acquired immune bodies was confirmed. The protection afforded by the vaccine was unsatisfactory when the pigs had received a rather large dose of anti-hog-cholera serum either within 4 weeks before or 1 week after vaccination. Inas-

much as suckling pigs from immune sows carry immune bodies derived from their dams, it was suspected that such pigs might not be adequately immunized by the vaccine. The practical importance of the question led to experiments on suckling pigs from immune sows in four farm herds, and the results apparently corroborated the suspicion, for the degree of protection was very unsatisfactory. In three herds of weaned pigs from immune sows the protection afforded by the vaccine was poor, fair, and perfect, respectively, depending perhaps on how long the pigs had been weaned when vaccinated. In one herd of suckling pigs from susceptible sows, 10-cc doses of vaccine appeared to afford satisfactory protection but 5-cc doses did not. In two herds of weaned pigs from sows of unknown history with regard to immunization, the results indicated that pigs respond to the vaccine better as they become older. Two herds of older pigs averaging 75 and 90 pounds, when vaccinated, and all from immune sows, were found to be immune even after a vaccine dose of only 5 cc. The immunity tests of all these farm herds were made from 3 to 4 months after vaccination and on a sufficient number of animals to be fairly representative of the herd. Undoubtedly the injection of vaccine constitutes a milder antigenic stimulus than the injection of virulent virus in the simultaneous method of immunization.

Inasmuch as commercial hog-cholera virus is an unstable product, fundamental research on various factors affecting retention of virulence was initiated. The factor chosen for immediate investigation was the influence of hydrogen-ion concentration. A comprehensive survey of the simultaneous virus at present commercially produced indicated that its hydrogen-ion concentration seldom falls outside the range pH 7.0 to 7.4. Samples of defibrinated virulent blood, preserved with either 0.5 percent of phenol or 40 percent of glycerin, were adjusted by the addition of acid or alkali to cover the range pH 3 to 9 and were stored at about 25° C. Periodical tests were made on susceptible pigs in order to determine when virulence had vanished. The results pointed to pH 5.0 to 5.5, representing a slightly acid medium, as optimal for the preservation of virulence. Under these conditions virulence appeared to persist three times as long as at pH 7.0. Unfortunately, the improvement cannot be directly applied to ordinary simultaneous virus because the mixture becomes too thick. Preliminary experiments indicate that the difficulty probably may be overcome by the incorporation of a moderate proportion of glycerin. Application has been made for a public patent covering acid hog-cholera virus.

DIPS, DISINFECTANTS, ANTISEPTICS, AND ANTHELMINTICS

During the year, 97 samples of dips, disinfectants, and related materials, mainly connected with regulatory work of the Bureau, were received for chemical or bacteriological examination. Inspectors in the field were provided with supplies for making the following tests: 505,800 tests of arsenical dipping baths, 6,500 tests of lime-sulphur dipping baths, 1,620 tests of nicotine dipping baths, and 3,600 tests for phenol content of virus and serum. Besides partial replacements, 403 new test outfits were provided. Twenty-nine stock cultures of micro-organisms were maintained.

It is important that biological products for injection into animals should not only be free from bacterial contamination when marketed, but also that they should be germicidally effective against harmful organisms which might gain access when a portion of the material is first withdrawn for use and might otherwise multiply and cause serious contamination of the residual material kept for later use. The tuberculin here prepared carries 0.55 percent of phenol. Analyses indicated that the phenol content of tuberculin contained in 4-dram homeopathic vials, closed with either rubber stoppers or cork stoppers sealed with glue and stored in darkness, diminished at the rate of slightly less than 0.01 percent per month. Similar results were obtained with 0.55-percent solutions of phenol in distilled water. No loss was detected when the tuberculin was stored in sealed glass ampules.

In experiments on the preservation of serum (clarified with bean extract) from hog blood, the following five antiseptics were tested: (1) Phenylmercuric acetate, 0.025 percent; (2) phenylmercuric acetate, 0.01 percent plus phenol, 0.25 percent; (3) sodium ethylmercurithiosalicylate, 0.05 percent; (4) sodium ethylmercurithiosalicylate, 0.01 percent plus phenol, 0.25 percent; (5) phenol, 0.5 percent. Uncontaminated serum was employed, and the antisepticized mix-

tures were stored at a temperature of about 2° C. After various periods of storage, subsamples were contaminated with a mixture of cultures of *Staphylococcus aureus*, *Salmonella suipestifer*, and *Escherichia coli* and were then held in an ordinary refrigerator for observation of the fate of the contaminants. In an immediate test, without preliminary storage, with contamination equivalent to about 10,000,000 organisms per cubic centimeter, all the antiseptics except (3) effected a steady diminution in the number of organisms. In subsamples contaminated after 3 months with about 250,000 organisms per cubic centimeter, all the antiseptics except (1) were effective. In subsamples contaminated after 6 months with about 275,000 organisms per cubic centimeter, (2), (3), and (4) effected sterility within 1 week and (1) was slowly effective, but (5), after effecting a reduction to 7,000 organisms per cubic centimeter in 3 days, permitted an increase to 150,000 in 1 week and to 2,400,000 in 2 weeks. In subsamples contaminated after 11½ months with about 450,000 organisms per cubic centimeter, (2), (3), and (4) were found still effective, but (1) and (5) failed to prevent growth. The possible effect of various preservatives on the potency of serums, or on animals treated with the serums, was not considered in this investigation.

In a continuation of the investigation on the effect of inorganic salts on the bacteriostatic power of crystal violet in defibrinated hog blood, it was found that the degree of alkalinity of the mixture may be a less important factor than the nature of the anion of the salt, the anions appearing increasingly effective in the following order: Hydroxide, carbonate, phosphate, borate. But tests frequently gave erratic results, possibly owing to varying grossness of the bacterial contamination.

In making direct tests of the germicidal power of disinfectants, it would be helpful to possess a reliable mathematical formula for correlating concentration of a disinfectant with the time required for killing the test organisms. The results of investigations pursued at various periods over several years now have been assembled for evaluation. One such formula appears reliable in proportion as the resistance of the cultures used approaches uniformity, but the data also indicate the difficulty of obtaining and maintaining cultures of highly uniform resistance.

In a continuation of previous work, a commercial mixture of dichloropentanes was found to deserve further investigation as a practical agent for destroying the viability of various stages of nematode parasites contained in horse manure. Normal butyl chloride, in admixture with linseed oil, was administered with gratifying results to horses harboring species of nematodes which cause serious debility. The same substance, in adequate dosage, was effective against whipworms in dogs. This work was conducted in cooperation with the Zoological Division.

MEAT FOOD PRODUCTS

It has recently been recognized that certain unsaturated fat acids essential for health may not be synthesized in sufficient quantity in the animal economy, even from other fatty substances. The best-known members of this group are linoleic and linolenic acids, and their lack in the body is conveniently termed "linoleic acid deficiency." White rats were given diets varying from fat-free to a high fat content of either oleo oil or lard but abundantly adequate in all other respects. The localized dermatosis which is a known characteristic symptom of linoleic acid deficiency was observed, but it was also found that important features of the syndrome are slow growth, poor digestion of such fat as may be present in the diet, and poor utilization of protein. Comparative feeding experiments indicated that beef fat as represented by oleo oil is deficient in these essential fatty acids and is definitely inferior to lard in that respect. The observation was made that white rats need no carbohydrate whatever for normal health and growth provided they receive a high fat diet that is adequate in other respects.

Comparative feeding experiments on white rats were made with sweet and highly rancid samples of both oleo oil and lard. No evidence of any directly harmful effect due to rancidity was observed, nor did rancidity either favor or retard the onset of the dermatosis characteristic of linoleic acid deficiency. Except when lard was fed at a low level, the animals consistently made more rapid and economical gains on sweet fat than on rancid fat.

TUBERCULIN AND MALLEIN

During the year, Bureau and State officials were supplied with 1,354,470 cc of intradermic mammalian tuberculin, 16,760 cc of intradermic avian tuberculin, and 856 cc of ophthalmic mallein. Forty-nine subcultures of *Mycobacterium tuberculosis* and nine of *Pfeifferella mallei* were supplied to other laboratories.

The intradermically active substance in mammalian tuberculin appears to be highly thermostable. No difference was detected in the potencies of tuberculins derived from cultures which, in the process of sterilization, had been heated in streaming steam for either 3 hours or 24 hours or autoclaved under 15-pound steam pressure for 3 hours.

The present synthetic medium used for growing the organisms in tuberculin production employs asparagin as the source of nitrogen. It was previously reported that ammonium malate afforded equally luxuriant growth. The ammonium salts of malonic, aspartic, and glutaminic acids may now be added to the list of substances containing highly available nitrogen. All the substances mentioned are derivatives of dicarboxylic acids. The ammonium salts of some other dicarboxylic acids (oxalic, succinic, glutaric, tartaric) afforded only moderate growth. The same was true of ammonium citrate. The ammonium salts of simple monocarboxylic acids (acetic, proprionic, butyric) and of monocarboxylic hydroxy acids (glycolic, lactic, oxybutyric) afforded insignificant growth. Glycine, however, was excellently utilized.

It is well known that changes in the reaction (pH value) of the culture medium tend to occur during the growth of the tuberculosis organism. The direction of the change, its magnitude, and the reversals in direction during growth are frequently extraordinary and indicate a complex sequence of biochemical processes. The properties of the derived tuberculin are affected by these changes in pH values. Through judicious selection of materials, culture media may now be prepared which will assume almost any desired pH value at any stage of growth of the organism.

In testing animals with tuberculin, the question frequently arises as to which type of organism (bovine, human, or avian) a positively reacting animal may be harboring. In the following experiments on intradermic tests the mammalian tuberculin was employed in tenfold the dilution of the avian tuberculin: Guinea pigs were highly sensitized to homologous tuberculin by the injection of living organisms of either the mammalian (bovine) or the avian type. Those sensitized with the mammalian type sometimes reacted slightly to avian tuberculin; those sensitized with the avian type failed to react to mammalian tuberculin. When sensitized with organisms of both types, either simultaneously or in sequence with a 2-month interval, they displayed normal sensitiveness to both types of tuberculin, which persisted at least 4 months.

DIAGNOSTIC ANTIGEN FOR PULLORUM DISEASE

Under the provisions of the national poultry improvement plan, 410 samples of commercial stained antigen for the whole-blood test for pullorum disease, representing the products of 20 licensed producers, were received for examination. Of the total volume of production represented by these samples, 1,638,000 cc were found to be satisfactory (85,000 after reprocessing), and 132,000 were condemned. Forty subcultures of *Salmonella pullorum* were supplied to producers of antigen.

DIAGNOSTIC TESTS FOR BANG'S DISEASE

Antigens for agglutination tests for Bang's disease were supplied to field employees in quantities sufficient for 22,000 rapid whole-blood tests, 93,000 serum plate tests, and 102,000 tube tests. In order to meet the demand for some method whereby different laboratories can standardize materials and technique in the interest of mutually consistent results, subsamples of 18 dried cattle serums of various titers were sent to 49 laboratories. In the preparation of these subsamples each serum was distributed among small vials in 1-cc portions. The vials were immersed in a bath cooled by solid carbon dioxide until the contained material was solidly frozen, and the contents were then evaporated to dryness under high vacuum while still in the frozen condition. Material thus dried keeps well and is readily soluble in cold distilled water to afford a reconstructed serum of definite titer. After careful study

of 17 strains of *Brucella abortus*, especially with respect to dissociation, 3 were selected as best suited for the production of plate antigen.

Investigations of the possible value of a skin test for Bang's disease were continued with a Berkefeld-filtered abortin. Intradermic injection of the product in the caudal fold of cattle elicited in allergic animals reactions which were fairly comparable in conspicuousness to tuberculin reactions. This abortin was used on 82 cattle in 3 herds in conjunction with agglutination tests and with a search for *Brucella* organisms in the milk from certain animals, but conclusions cannot yet be drawn.

FIELD INSPECTION DIVISION

Activities relating to the control and eradication of scabies of sheep and cattle and various other animal diseases were continued by the Field Inspection Division, under the direction of G. W. Pope, chief, until his retirement February 28, 1937, and after that time by his successor, S. O. Fladness. This Division also continued to administer regulations to prevent the introduction of livestock diseases of foreign origin as well as regulations governing the inspection, humane treatment, and safe transport of export animals.

ERADICATION OF SCABIES

Sheep-scabies eradication went forward as in previous years in cooperation with authorities of the various States. Inspections in the field and supervised dippings numbered, respectively, 14,745,419 and 1,449,427. Flocks in which infection was found included 42,998 sheep; less than one-third as many as in the previous year. There was continued freedom from the disease in the vast range areas of the West except for a few cases in New Mexico, and that State also was believed to be free at the close of the year. The principal problem at present is the scattered infection in several Midwestern States where, because of transportation and marketing factors, eradication presents many difficulties. Gratifying progress was made in Ohio, Iowa, and South Dakota.

In the cooperative cattle-scabies-eradication work, the principal remaining centers of infection are in 1 county in southeastern New Mexico and about 15 counties in northwestern Nebraska. There is also some scattered infection in western Kansas. As a result of clean-up activities continued in Wyoming and Colorado, those States were believed to be entirely free at the close of the year. A reintroduction of the disease into Oklahoma was vigorously handled. Outbreaks of sarcoptic scabies in western Texas and eastern New Mexico are believed to have been successfully eradicated. During the year 2,679,768 inspections were made in the field, and supervised dippings numbered 463,240. Infection was found in 383 herds containing 229,277 cattle.

Some scabies infection continued to be found among goats in southwestern Texas, 8,183 head being affected out of 256,545 inspections.

No scabies among horses was reported during the year, and it is believed that eradication of this disease has been definitely completed.

ERADICATION OF DOURINE

There was no change during the year in the situation with respect to the existence of dourine, which is believed to be now practically eradicated from the United States. The area where some slight infection remains continued under State quarantine. A number of horses moving out of the area were tested, only two positive reactions being recorded.

CONTROL OF ANTHRAX

The country again was fortunate in escaping any serious outbreaks of anthrax during the year covered by this report. Bureau employees continued to furnish assistance in administering preventive treatment to Indian-owned cattle on reservations in localities where infection is known to exist.

INSPECTION OF HORSES FOR INTERSTATE SHIPMENT

Incidental to other duties in the field, Bureau employees inspected 3,752 horses and mules, of which 1,906 were mallein tested without any positive reactions. Glanders is not now known to exist in the United States.

INSPECTION AND QUARANTINE OF IMPORTED ANIMALS

All horses, ruminants, and swine offered for importation were carefully inspected. Importations from Canada and Mexico continued to be large, the total number being approximately the same as that of the previous year. There was a considerable increase in importations of breeding animals, which came largely from the Channel Isles and other island countries. The number of animals quarantined at ports of entry was about twice that of the previous year. The number and kind of animals imported during the year are shown in table 1. A small number of domestic fowls and pigeons also were inspected at ports of entry.

TABLE 1.—*Animals inspected for importation, fiscal year 1937*

Port of entry	Cattle	Swine	Sheep	Goats	Horses and mules	Asses	Other animals
Baltimore					7		7
Boston	73				78	1	11
Galveston						4	
Honolulu, Hawaii							2
Los Angeles					36		3
Miami					26		
New Orleans					14		5
New York	538	4	98	14	1,046	4	100
Port Everglades					5		
Portland, Oreg							4
San Francisco			1		17		14
San Juan, P. R	1,533	35		8	13	3	1
Tampa					12		
Canadian border ports	233,935	83,405	2,969	59	13,493	25	3
Mexican border ports	221,094	273	5,311	72	9,073	360	88
Total	457,173	83,717	8,379	153	[1] 23,820	397	238
Held in quarantine	541	10	99	14	19		104
Refused entry—							
From Mexico [2]	6,913				681		13
From Canada	105						
From Northern Ireland	3						
Under bond for reexport	12,521	69		52	170		

[1] Of this number 3,034 were mules. [2] Owing to tick infestation.

Bureau inspectors at border ports of entry again rendered assistance to the Bureau of Biological Survey in the inspection and quarantine of quail imported from Mexico. The number of birds offered for entry during the year was 101,396, almost four times that of the previous year.

The Bureau of Customs and the Public Health Service continued their valuable assistance in the administration of import regulations. Public Health surgeons obtained 13,640 declarations by shipmasters showing the presence or absence on their vessels of prohibited meats and livestock. Customs officers cooperated in preventing the landing of such products. Prohibited meats were shown to be present on 3,643 vessels and prohibited livestock on 25. All such animals, totaling 66, were slaughtered and the portions of the ship occupied by them disinfected under supervision. All these figures exceeded those of the previous year.

CONTROL OF IMPORT ANIMAL BYPRODUCTS, HAY, AND STRAW

In the administration of regulations designed to prevent the introduction of foot-and-mouth disease, rinderpest, and anthrax, careful supervision and control were exercised over import animal byproducts and feeding materials, as in previous years. Establishments receiving restricted import products were required to provide proper facilities for separate storage and for the disinfection of the products or the disinfection or control of effluents. All cars, trucks, ship compartments, and premises involved in the handling of these products were disinfected. The number of cars thus treated was 2,221.

Uncertified hay and straw packing materials originating in countries where foot-and-mouth disease exists were destroyed under supervision. Instances of this kind are now comparatively few.

Control over importations of calf stomachs and animal glands from countries where foot-and-mouth disease exists was continued.

The importation of animal manure from various countries was controlled through the requirement that prior permits be obtained.

Enforcement of laws and regulations prohibiting the landing of fresh meats or garbage from vessels which had provisioned in countries where foot-and-mouth disease exists was given special attention. Customs officers as well as local sanitary authorities rendered valuable assistance in this work.

INSPECTION AND SAFE TRANSPORT OF EXPORT ANIMALS

Animals totaling 8,115 head were inspected prior to exportation in accordance with Department regulations and in order to meet requirements of destination countries. Those shipped by water were afforded the protection specified in the regulations governing space, fittings, and equipment for humane treatment and safe transport. The number and kinds of export animals inspected are shown in table 2.

TABLE 2.—*Inspection and testing of animals for export, fiscal year 1937*

Kind of animal	To Canada	To other countries	Total	Kind of animal	To Canada	To other countries	Total
Cattle	103	2,044	2,147	Mules	10	1,301	1,311
Swine	1	154	155	Asses		2	2
Sheep	65	2,209	2,274	Other animals		4	4
Goats	23	848	871				
Horses	272	1,079	1,351	Total	474	7,641	8,115

MEAT INSPECTION DIVISION

The activities of the Meat Inspection Division, directed during the year by E. C. Joss, chief, show an increase of approximately 15 percent over the previous year in animals and their products inspected.

GENERAL MEAT INSPECTION

Inspection was conducted at 712 establishments located in 255 cities and towns, as compared with 725 establishments in 256 cities and towns during the fiscal year 1936. Inspection was inaugurated at 28 establishments and withdrawn from 37, as compared with 19 and 41, respectively, during the preceding year. Inspection was withdrawn from the number stated on account of discontinuance of operations involving the preparation of meat and meat food products for interstate or foreign commerce. At the close of June 30, 1937, there were 675 establishments in 245 cities and towns operating under inspection.

At establishments operating under this inspection, 71,223,306 animals were slaughtered and 7,740,872,352 pounds of meat and meat food products were cured, canned, chopped, rendered, refined, and otherwise prepared. Cooperation was given the Navy Department, Marine Corps, Veterans' Administration, and several other branches of the Government in the selection and preparation of meat supplies. Special service was performed for the Federal Surplus Commodities Corporation covering the supervision of the storage, handling, and shipping of hides and skins. Also, in connection with drought- and flood-relief activities, ante-mortem and post-mortem inspections of about 5,000 animals were made, and Bureau inspectors supervised the storage and shipments of the resulting meat products.

ANTE-MORTEM AND POST-MORTEM INSPECTIONS

The results of the ante-mortem and post-mortem inspections are given in tables 3 to 6, inclusive. Tables 4, 5, and 6 show the diseases and number of condemnations on ante-mortem and post-mortem inspections.

TABLE 3.—*Ante-mortem and post-mortem inspections of animals, fiscal year 1937*

Kind	Ante-mortem inspection				Post-mortem inspection		
	Passed	Suspected [1]	Condemned [2]	Total	Passed	Condemned [2]	Total
Cattle	10,779,859	120,852	4,005	10,904,716	10,829,049	71,582	10,900,631
Calves	6,396,145	9,464	3,924	6,409,533	6,390,615	23,205	6,413,820
Sheep and lambs	17,653,249	3,605	6,304	17,663,158	17,610,951	45,847	17,656,798
Goats	12,653	10	22	12,685	12,614	49	12,663
Swine	36,150,136	75,343	11,876	36,237,355	36,128,236	98,073	36,226,309
Horses [3]	13,066	19	21	13,106	12,972	113	13,085
Total	71,005,108	209,293	26,152	71,240,553	70,984,437	238,869	71,223,306

[1] "Suspected" is used to designate animals suspected of being affected with disease or condition that may cause condemnation in whole or part on special post-mortem inspection.
[2] For causes and additional condemnations see tables 4 to 6, inclusive.
[3] Horses are slaughtered and the meat thereof handled and prepared in establishments separate and apart from those in which cattle, calves, sheep, goats, and swine are slaughtered and the meat thereof handled and prepared.

TABLE 4.—*Number of animals condemned for various diseases and conditions on ante-mortem inspection, fiscal year 1937*

Cause of condemnation	Cattle	Calves	Sheep and lambs	Goats	Swine	Horses
Abscess					32	
Arthritis					27	
Ascites					2	
Bighead (plant poisoning)			60			
Blackleg		1				
Emaciation	29	13	1		86	
Enteritis					53	
Epithelioma	12	2	1			
Hog cholera					514	
Immaturity		45			7	
Influenza					25	
Injuries	6	11	1		1	
Metritis	1					
Moribund [1]	3,924	3,827	6,226	22	10,635	20
Necrobacillosis					10	
Omphalophlebitis		2				
Pericarditis	2					
Pneumonia	8	20	8		52	
Pyemia					24	
Pyrexia	19	3	7		396	
Recent parturition	1					
Septicemia	1				10	
Tetanus	1				1	1
Tumors	1				1	
Total	4,005	3,924	6,304	22	11,876	21

[1] Includes animals found dead in the ante-mortem pens when inspection was conducted.

TABLE 5.—*Number of animals condemned for various diseases and conditions on post-mortem inspection, fiscal year 1937*

Cause of condemnation	Cattle	Calves	Sheep and lambs	Goats	Swine	Horses
Actinomycosis	1,470	43			2	
Anaplasmosis	36	2				
Anthrax					51	
Arthritis and other bone diseases	139	318	566		5,153	
Asphyxia	7	5	11		287	
Blackleg	16	10				
Caseous lymphadenitis			6,114	3		
Cellulitis					5	
Contamination	7	8	6		2,349	
Cysticercosis	188	19	545		39	
Dropsical diseases	64	2	5		34	
Emaciation	14,119	6,257	13,038	22	455	25
Gangrene	11	1			1	
Hog cholera					12,360	
Hydremia	1					
Hydronephrosis	3		1		88	
Icterus	161	564	3,319	3	4,591	
Immaturity		7,380	28	1		
Injuries	4,648	862	1,582	2	1,921	1
Johne's disease	2					
Melanosis	46	147	90		147	52
Necrobacillosis	12		1			
Omphalophlebitis		161				
Parasitic diseases	104	2	73		897	
Pneumonia, pleurisy, enteritis, peritonitis, etc	27,243	5,455	15,718	8	25,878	18
Pregnancy and recent parturition	12				2	
Pseudoleukemia	1,485	58	22		230	
Septicemia and pyemia	11,492	1,726	3,954		22,960	12
Sexual odor				7	4,293	
Skin diseases			3		31	
Splenetic fever	1	1				
Toxemia	4	2			1	
Tuberculosis	6,284	119	22		15,854	
Tumors, carcinomata, sarcomata, etc	3,811	34	68	3	341	5
Uremia	184	29	681		103	
Xanthosis	32					
Total	71,582	23,205	45,847	49	98,073	113

TABLE 6.—*Number of parts of carcasses,*[1] *of animals indicated, condemned for various diseases, and conditions on post-mortem inspection, fiscal year 1937*

Cause of condemnation	Parts of carcasses of—				
	Cattle	Calves	Sheep and lambs	Swine	Horses
Actinomycosis	209,347	8,358		2	
Arthritis and other bone diseases	26	3	4	93	
Caseous lymphadenitis			13		
Cellulitis	8	2		950	1
Contamination	139	700	349	2,537	
Hydrocephalus		4			
Injuries	1,977	132	104	31,133	
Melanosis	29	60			5
Necrosis	35	1			
Tuberculosis	11,558	131		223,764	
Tumors and abscesses	12,615	4,642	127	353,964	
Xanthosis	2				
Total	235,736	14,033	597	612,443	6

[1] In addition to the above parts, 980,555 cattle livers and 37,581 calf livers were condemned on post-mortem inspection.

INSPECTION OF MEAT AND MEAT FOOD PRODUCTS

Meat and meat food products prepared and processed under supervision are shown in table 7, which is a record only of inspection performed and not a statement of the actual quantity prepared. Market inspection to facilitate interstate delivery of meat and meat food products was conducted in seven cities.

TABLE 7.—*Inspection of meat and meat food products prepared and processed under supervision, fiscal year 1937* [1]

Product	Quantity	Product	Quantity
	Pounds		*Pounds*
Meat placed in cure:		Bacon, sliced	216, 030, 818
Beef	156, 050, 411	Lard:	
Pork	2, 095, 783, 056	Rendered	820, 159, 828
Smoked and/or dried:		Refined	642, 836, 921
Beef	66, 400, 331	Oleo stock	133, 737, 059
Pork	1, 189, 027, 797	Edible tallow	94, 116, 947
Sausage:		Compound containing animal fat	482, 508, 411
Fresh, finished	111, 814, 183	Oleomargarine containing animal fat	60, 438, 435
Smoked and/or cooked	602, 568, 181	Miscellaneous	56, 138, 311
To be dried or semidried	122, 495, 936	Horse meat:	
Loaf, headcheese, chili con carne, jellied products, etc	104, 072, 641	Cured	1, 469, 550
Cooked meat:		Chopped	90, 005
Beef	14, 690, 625	Canned	2, 849, 157
Pork	151, 761, 606		
Canned meat and meat food products:		Total	[2] 7, 740, 872, 352
Beef	112, 160, 474		
Pork	140, 112, 808		
Sausage	42, 376, 133		
Soup	262, 834, 776		
All other	58, 347, 952		

[1] The following quantities of meat and meat food products were condemned on reinspection and destroyed for food purposes on account of having become sour, tainted, rancid, unclean, or otherwise unfit for human food: Beef, 1,882,431 pounds; pork, 5,218,746 pounds; mutton and lamb, 45,053 pounds; veal, 44,433 pounds; goat meat, 320 pounds; total, 7,190,983 pounds.

[2] This figure represents "inspection pounds" as some of the products may have been inspected and recorded more than once due to having been subjected to more than 1 processing treatment such as curing first and then canning.

MEAT AND MEAT FOOD PRODUCTS CERTIFIED FOR EXPORT

During the fiscal year 22,882 official meat-inspection certificates were issued to cover the exportation of the following products: Beef and beef products, 35,030,584 pounds; mutton and lamb and their products, 2,852,471 pounds; pork and pork products, 173,861,891 pounds; horse meat and its products, 1,517,130 pounds; total, 213,262,076 pounds. There were also issued 3,717 certificates covering the exportation of 52,491,472 pounds of inedible animal products.

EXEMPTION FROM INSPECTION

The provisions of the meat-inspection law requiring inspection usually do not apply to animals slaughtered by farmers on farms nor to retail butchers and dealers supplying their customers. Farmers, butchers, and dealers, however, are required to furnish shippers' certificates, thus providing the Bureau with a record of their shipments. In addition, the retail butchers and dealers, in order to ship meat and meat food products in interstate or foreign commerce, are required to obtain certificates of exemption from inspection. During the year 145 of these certificates were issued and 64 were canceled. The number of such certificates outstanding at the close of the year was 1,136. Cancelations were on account of the certificate holders' retiring from business, ceasing to make interstate shipments, change of address, change of ownership, insanitary conditions, shipment of unsound meat, the use of prohibited preservatives, and other causes.

During the year 86,929 shipments were made by retail butchers and dealers holding certificates of exemption as compared with 85,364 shipments during the fiscal year 1936. The shipments of the year covered products as shown in table 8.

TABLE 8.—*Shipments by retail butchers and dealers under certificates of exemption, fiscal year 1937*

Product	Carcasses	Quantity	Product	Carcasses	Quantity
	Number	*Pounds*		*Number*	*Pounds*
Cattle (2,977 quarters)	744	303, 302	Cured meats		1, 034, 271
Calves	27, 076	1, 784, 783	Lard		36, 460
Sheep and lambs	556	25, 249	Sausage		278, 607
Swine	1, 183	31, 370	Miscellaneous (headcheese, suet, scrapple, compound, etc.)		86, 100
Beef, fresh		4, 805, 133			
Veal, fresh		622, 386			
Mutton and lamb, fresh		833, 919			
Pork, fresh		698, 558	Total	29, 559	10, 540, 138

During the year 56,619 interstate shipments were made of meat and meat food products from animals slaughtered by farmers on the farm, as compared with 58,792 shipments during the fiscal year 1936. The products composing these shipments are shown in table 9.

TABLE 9.—*Shipments of farm-slaughtered meat and meat food products, fiscal year 1937*

Product	Carcasses	Quantity	Product	Carcasses	Quantity
	Number	*Pounds*		*Number*	*Pounds*
Cattle (1,797 quarters)	449	180,968	Cured meats		493,337
Calves	127,076	8,534,065	Lard		5,813
Sheep and lambs	3,876	107,530	Sausage		155,086
Swine	9,975	202,947	Miscellaneous (scrapple, headcheese, livers, souse, etc.)		81,629
Beef, fresh		39,769			
Veal, fresh		291,222			
Mutton and lamb, fresh		6,151			
Pork, fresh		117,682	Total	141,376	10,216,199

INSPECTION OF MEAT AND MEAT FOOD PRODUCTS OFFERED FOR ENTRY INTO THE UNITED STATES

Table 10 shows foreign meat and meat food products inspected and passed when offered for entry into the United States, with the principal countries of origin and the kind and quantity of products.

TABLE 10.—*Foreign meat and meat food products passed for entry, fiscal year 1937*

Country of origin	Fresh meats			Canned meats			Cured meats	
	Beef and veal	Pork	Mutton and lamb	Beef	Pork	Other	Beef	Pork
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Argentina				33,960,938	144,037	25,644	258	2,326,965
Australia	5,149		899	18				31,887
Brazil				20,862,626		18	913,549	99,665
Canada	1,375,820	14,800,978	25,537		928	5,356	77,276	3,558,227
Denmark		27		178	967,961	16,016		139,344
Estonia					506,692	462		656
Germany					392,397	9,207		108,849
Great Britain	55				407	3,377		277,876
Hungary				106	2,143,272	2,327	263	2,756
Italy					94	4,046		15,238
Lithuania	260	2,762,996	2,734		386,485	3,395		103,498
Netherlands					1,270,616	54,078		111,760
New Zealand	375,157	430	74,814					
Paraguay				1,173,183				
Poland	869	511,026			26,285,909	1,206,559		1,912,205
Uruguay				21,004,798	1,326	170	678,320	11,209
Other countries	28,124	124,215		35,022	280,258	121,643	15,300	325,254
Total	1,785,434	18,199,672	103,984	77,033,869	32,380,382	1,452,298	1,684,966	9,025,389

Country of origin	Sausage (not canned)	Oleo products	Edible tallow	Miscellaneous	Total
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Argentina	56,627	3,709,427	11,333,157	488,112	52,045,165
Australia	37	782,881		2,530	823,401
Brazil	376		3,268,765	119,616	25,264,615
Canada	181,050	290,328	1,925,926	1,701,089	23,942,515
Denmark	57,380			36,335	1,217,241
Estonia				36	507,846
Germany	114,703			19,940	645,096
Great Britain			200	146,808	428,723
Hungary	27,716			130	2,176,570
Italy	460,332				479,710
Lithuania				1,349	3,260,717
Netherlands	7,717			6,610	1,450,781
New Zealand		45,546	246,021	23,781	765,749
Paraguay					1,173,183
Poland	102,604			27,863	30,047,035
Uruguay		766,361	176,880	8	22,639,072
Other countries	8,037			134,259	1,072,112
Total	1,016,579	5,594,543	16,950,949	2,708,466	167,939,531

Table 11 shows the kind and quality of foreign meat and meat food products refused entry or condemned on account of unsoundness, presence of prohibited preservatives, mislabeling, defective canning, or other cause.

TABLE 11.—*Foreign meat and meat food products refused entry and condemned, fiscal year 1937*

Product	Condemned	Refused entry	Product	Condemned	Refused entry
	Pounds	*Pounds*		*Pounds*	*Pounds*
Beef:					
Fresh	108		Mutton, canned	18	
Cured	3,977		Oleo products	151,004	
Canned	32,206	568,352	Edible tallow	86,570	139,609
Pork:			Sausage	22,924	12,684
Fresh	35,854	1,389	Miscellaneous	935	635
Cured	65,932	260,509			
Canned	51,576	30,376	Total	451,104	1,013,554

FOREIGN ANIMAL CASINGS RELEASED FOR ENTRY OR REFUSED ENTRY

Animal casings from 57 foreign countries were released for entry as follows: On certification, 16,850,321 pounds, of which 137,915 were dried casings; on disinfection 3,069,226 pounds; total, 19,919,547 pounds. Casings amounting to 8,294 pounds were refused entry and removed from the United States.

INSPECTIONS FOR OTHER BRANCHES OF THE GOVERNMENT

By request of other Government agencies, meat and meat food products were inspected for condition and conformance to specifications as shown in table 12.

TABLE 12.—*Inspections for other branches of the Government,*[1] *fiscal year 1937*

Branch of Government	Passed	Rejected	Branch of Government	Passed	Rejected
	Pounds	*Pounds*		*Pounds*	*Pounds*
Navy Department	54,702,031	1,637,710	Maritime Commission	241,821	2,780
Veterans' Administration (hospitals and homes)	6,150,468	209,299	Inland Waterways Corporation	94,606	10,763
Department of Justice (Federal penitentiaries)	2,999,405	83,823	Alaskan Engineering Commission	55,443	7,049
Marine Corps	2,993,038	100,051	Tennessee Valley Authority	41,224	
Department of Interior (Bureau of Indian Affairs)	1,024,909	15,408	Forest Service	155	
Coast Guard	592,128	10,382	Total	69,405,249	2,085,994
War Department (Army Engineering Corps)	510,021	8,729			

[1] Not including inspections for emergency and relief agencies.

INSPECTIONS FOR FEDERAL SURPLUS COMMODITIES CORPORATION

At the request of the Federal Surplus Commodities Corporation, special assistance was given in the supervision of the storage, handling, and shipping of hides and skins. Ante-mortem and post-mortem inspections also were made of such animals as were slaughtered in connection with drought- and flood-relief activities, and the storage and shipments of the resulting meat food products were supervised by Bureau inspectors.

MEAT-INSPECTION LABORATORIES

Analyses and examinations of meat and meat food products were conducted in the meat-inspection laboratories situated in the several districts throughout the country. The number of samples examined was 38,881, of which 3,088 were not in accordance with the regulations. Included among these were meats, meat food products, edible fats and oils, cereals, spices, curing materials, colors, denaturing substances, water supplies, and miscellaneous articles.

Of the samples found at fault, 2,153 represented products which had been prepared in inspected establishments. The principal faults found in these establishments were excessive added water in sausage, excessive fatty tissue in

pork sausage, improper application of artificial color to sausage casings, and failure to declare added substances permitted to be used under appropriate declaration. Of the samples found at fault, 570 represented products offered for use in connection with the preparation of meat and meat food products and were excluded on account of laboratory findings. Samples of 200 consignments of meat and meat food products offered for importation from foreign countries were found at fault through examination at the laboratories. Most of these were mislabeled and were admitted after correction of the labels, a few consignments being refused entry. Some, however, represented consignments of canned meat containing an unduly large proportion of cans of unsound or suspicious meat. Of 1,414 samples of water supplies for official establishments, 181 were found to be polluted. Corrective action was taken in all cases.

LABELING MEAT AND MEAT FOOD PRODUCTS

During the year 22,794 labels and other markings for meat and meat food products were approved, whereas 1,764 were disapproved, principally because of the inclusion of statements or designs which were false or misleading as to quality, quantity, ingredients, origin, or disease-preventive or curative properties.

DRAWINGS AND SPECIFICATIONS

There was a considerable increase in the number of sets of drawings and specifications of projects for new plants, for additions to inspected establishments, and for alterations of such establishments which were presented for Bureau consideration during the year. The increase in the ratio of drawings and specifications which were approved to the number which were presented for approval is noticeable and is indicative of the excellent cooperation extended by establishments.

PACKERS AND STOCKYARDS DIVISION

The work of the Packers and Stockyards Division was directed during the year by A. W. Miller, chief. Under the Packers and Stockyards Act the activities involved supervision over the operations and practices of packers, stockyard companies, market agencies, and dealers in connection with livestock, and of licensees in connection with live poultry, and rates and charges for services at stockyards and at designated live-poultry markets. Under the livestock quarantine laws and regulations the activities included the inspection of all livestock received at public stockyards, enforcement of the 28-hour law, and cooperation with the various States in applying their laws and regulations designed to prevent the introduction of animal diseases.

FORMAL PROCEEDINGS UNDER THE PACKERS AND STOCKYARDS ACT

On July 1, 1936, 32 formal dockets were pending. During the year 312 new dockets were instituted and 5 were reopened. Final action was taken on 200 of these cases, and 149 were pending on June 30, 1937. Of the 312 new dockets instituted, 4 involved reasonableness of rates; 34, trade practices and reparation; 7, failure to maintain bonds; 7, insolvency; and 260, applications for poultry licenses. The 5 dockets reopened involved reasonableness of rates and poultry license. Cease-and-desist and suspension orders were issued in 12 dockets, suspenion orders in 4, reparation orders in 3, orders prescribing reasonable rates and charges in 9, orders granting licenses in 122, orders denying licenses in 19, orders suspending licenses in 4, orders of dismissal in 24, and miscellaneous orders in 3. Copies of the orders in any of these cases may be had on request to the Bureau.

CASES IN COURT PERTAINING TO THE PACKERS AND STOCKYARDS ACT

Pursuant to an order of the Supreme Court of the United States in the case involving an order of the Secretary prescribing a schedule of reasonable commission rates for the market at Kansas City, Mo., the case was remanded to the lower court of three Federal judges. During the year further hearings were held before that court on the question at issue as to whether the respondents had been given a full hearing in the proceedings before the Secretary. The matter was pending before the court at the close of the year.

A hearing was held before a statutory court of three Federal judges in Denver, Colo., during the year on application of the Denver Union Stock Yard

Co. to have an order of the Secretary prescribing a schedule of reasonable charges for that company set aside. The case was pending before the court at the close of the year.

During the year a Federal district court in Philadelphia, Pa., issued an opinion in the case involving an application by poultry dealers in that city for a restraining order against the enforcement of the provisions of title V of the Packers and Stockyards Act. The court held that the provisions of title V are constitutional and that the Secretary had not acted in an arbitrary manner in designating Philadelphia under the terms of that title, and the proceedings were dismissed.

During the year a Federal statutory court of three judges in East St. Louis, Ill., issued an order requiring market agencies at National Stock Yards, Ill., to make refunds of commissions paid by shippers in excess of a schedule of reasonable rates prescribed by the Secretary, and all refunds were completed at the close of the year.

During the year an order was issued requiring the Great Atlantic & Pacific Tea Co. to cease and desist from certain violations of title II of the act. The respondent applied to a Federal circuit court of appeals for an order to restrain the enforcement of the Secretary's order. The case was pending before the court at the close of the year.

During the year Federal district courts imposed penalties on various persons for engaging in the business of handling live poultry in commerce without having a license as required by title V of the act, and for engaging in business at posted stockyards without having registered as required by other provisions of the act.

The case instituted during the preceding year in a Federal district court against the Bonner Stock Yard, Fort Smith, Ark., for failure to comply with an order of the Secretary in connection with the bond regulation, was dropped during the year, the defendant having discontinued business.

LIVE-POULTRY DEALERS AND HANDLERS

Further investigations were made and an informal hearing was held in St. Louis, Mo., for the purpose of determining whether the facts would warrant recommendation that St. Louis be designated as coming under the provisions of title V of the Packers and Stockyards Act. The matter was pending at the close of the year. Investigations were being continued for the same purpose at Cincinnati, Ohio, and some other points.

STOCKYARDS

On June 30, 1936, there were 124 stockyards posted as coming within the jurisdiction of the Packers and Stockyards Act. During the year 20 stockyards were posted as coming within the jurisdiction of the act, and 4 were released. At the close of the year the number of stockyards posted under the act was 140.

REGISTRATIONS

On June 30, 1937, there were 1,563 market agencies and 2,866 dealers registered to operate at posted stockyards. During the year 271 market agencies and 306 dealers were registered, and 221 market agencies and 241 dealers were placed on the inactive list.

LICENSES

During the year 599 licenses were issued under title V of the Packers and Stockyards Act, which requires persons engaged in business in connection with the handling of live poultry or the furnishing of facilities or services in connection therewith to obtain licenses. Forty-seven licenses were rendered inactive owing to the fact that the licensees are no longer engaged in business. A number of hearings have been held for the purpose of determining whether or not applicants were entitled to receive licenses, and at the close of the year 861 licenses were in effect at designated markets.

RATES AND CHARGES

An order was issued prescribing reasonable rates and charges for stockyard services at the Union Stock Yards, Denver, Colo. Extensive hearings were held

involving the reasonableness and lawfulness of the rates and charges at the Union Stock Yards, Chicago, Ill. A petition was filed by the St. Joseph Stock Yards Co., South St. Joseph, Mo., requesting a modification of its rates and charges, and after an investigation by the Department certain modifications were made in the order of the Secretary. A petition was filed by the Union Stock Yards Co., of Omaha, Nebr., and investigations are being made to determine whether the petition for the modification should be granted. Valuations have been made of the stockyard properties of the Sioux Falls Stock Yards Co., Sioux Falls, S. Dak.; Fort Worth Stock Yards Co., Fort Worth, Tex.; and the Cincinnati Union Stock Yard Co., Cincinnati, Ohio.

An order was issued prescribing reasonable rates and charges for selling and buying livestock on commission at the New Orleans Stock Yards, Arabi, La. Petitions were filed by the market agencies at the Chicago Union Stock Yards and the St. Louis National Stock Yards requesting modification of the orders of the Secretary prescribing rates and charges for selling and buying livestock on commission. After investigations the orders of the Secretary were modified in certain respects. Petitions were filed by the market agencies at the Denver Union Stock Yards and the Kansas City Stock Yards requesting modification in the orders of the Secretary prescribing rates for selling and buying livestock on commission. Investigations are being made and these petitions are pending.

An audit of the books and records of the market agencies at the Cincinnati Union Stock Yards was completed during the year, and a conference was held with representatives of the market agencies with respect to the rates and charges for selling and buying livestock on commission at that market. This matter is still pending. An order was issued prescribing reasonable rates and charges for unloading poultry from cars in the designated city of New York. Hearings were held involving the rates and charges for trucking poultry and the rental of coops in the designated area of New York and Jersey City. An order is in the course of preparation.

BONDS

Market agencies and dealers in general have complied with the bond regulation, but in those cases in which bonds were not furnished and could not be obtained through informal action, formal proceedings were instituted to compel compliance with the bond regulation. On account of the higher market prices for livestock, the amount of bonds carried by market agencies and dealers has been materially increased.

TRADE PRACTICES

Supervisors continued, as in past years, to make investigations and reports on general marketing practices and conditions, both with respect to livestock and live poultry. They assisted in handling matters relating to the filing of tariffs and regulations of market agencies, stockyard companies, and licensees. A large number of complaints involving alleged violations of the various provisions of the Packers and Stockyards Act were received and carefully investigated by supervisors and special investigators in the field.

A considerable number of trade-practice audits of the records of market agencies, dealers, and licensees were made at various stockyards and designated cities, some of which revealed conditions that required the institution of formal proceedings.

An extensive hearing involving alleged violations of title II of the act by one of the large packing concerns was completed during the year, and the record was being studied with a view to bringing the case to a conclusion as soon as possible after the close of the year.

SCALES AND WEIGHING

During the course of the year Bureau weight supervisors visited practically all posted stockyards and all cities designated under the provisions of title V of the act. They inspected and supervised tests of scales at stockyards and investigated weighing operations and the condition of scales in designated areas. Considerable progress was made in some of these areas, in cooperation with local authorities, to bring about a systematic and thorough testing and inspection of scales used for weighing live poultry by licensees, and efforts to set up similar conditions in other areas were under way at the close of the year. In all cases

where scales were found to be defective or not weighing within the tolerances permitted by the Bureau, the owners were required to have the scales repaired, corrected, and put in satisfactory condition. In general the Bureau received good cooperation from various agencies in its scale-testing and supervisional work.

AUDITS AND ACCOUNTS

Accountants of the Bureau made a detailed audit of the books and records of the Cincinnati Union Stock Yard Co. for 1932 to 1936, inclusive, in the course of an investigation as to the reasonableness of its rates and charges. Detailed audits and tabulations of 31 market agencies at the same market were made in connection with a similar investigation as to the reasonableness of their commission charges. At Chicago and National Stock Yards, Ill., accountants supervised and assisted in the analyses of audits and tabulations submitted in connection with petitions for modification of commission-rate orders, and at the close of the year similar work was being carried on at the Denver, Colo., market. Accountants also supervised the disposition of the impounded funds accumulated in commission-rate cases at the Chicago and National Stock Yards, Ill., markets. Accountants made audits at Omaha, Nebr., and St. Joseph, Mo., in connection with petitions for modification of stockyard-rate orders, and an order reducing yardage charges at St. Joseph was issued. At the close of the year accountants were engaged in making a 5-year audit of the books and records of the stockyard company at Fort Worth, Tex., in connection with its rates and charges. An audit investigation was also made at Milwaukee, Wis., as to the reasonableness of fire-insurance charges on livestock. Accountants also made routine audits of the books and records of 9 stockyard companies, financial and insolvency audits in connection with the operations of 28 market agencies, and trade-practice audits of 8 such firms.

The poultry amendment to the Packers and Stockyards Act considerably increased the accounting work of the Division. Audits were made of the books and records of the patent-car unloading contractors and the coop and truck-service companies at New York in connection with investigations to determine the reasonableness of their rates and charges in the furnishing of facilities for the handling of live poultry. In addition, audits were made of the books and records of 209 applicants for licenses in connection with hearings held to determine whether they were financially able to meet their obligations as licensees.

SUMMARIES OF REPORTS

Information compiled from the annual reports received from packers, stockyard companies, market agencies, and dealers is shown in tables 13 to 18, inclusive. The various reports cover business during the calendar year, with a few exceptions, which are on the basis of the fiscal year.

TABLE 13.—*Financial results of operations during 1936 for 815 packers subject to the Packers and Stockyards Act, grouped according to federally and nonfederally inspected slaughtering and nonslaughtering concerns*

Group	Concerns	Average net worth [1]	Net sales	Net gain
	Number	*Dollars*	*Dollars*	*Dollars*
Federally inspected slaughterers	195	656, 407, 650	2, 751, 700, 049	30, 346, 441
Nonfederally inspected slaughterers	394	51, 841, 403	269, 593, 187	2, 582, 253
Nonslaughterers [2]	226	181, 233, 265	396, 254, 877	19, 004, 446
Total	815	889, 482, 318	3, 417, 548, 113	51, 933, 140

[1] These figures represent the numerical average of the total net worth of reporting concerns at the beginning and end of their fiscal years.
[2] This group includes concerns which also handle commodities other than meat food products.

In addition to the complete reports from 815 packing concerns, financial details, lacking in some respects, were received from 15 other packers for the year 1936.

TABLE 14.—*Comparison of the operations of packers subject to the Packers and Stockyards Act, 1932–36*

Item	1932 (868 concerns)	1933 (871 concerns)	1934 (851 concerns)	1935 (845 concerns)	1936 (815 concerns)
Average net worth [1]	$941, 046, 982	$921, 602, 012	$882, 571, 885	$852, 538, 940	$889, 482, 318
Total income	2, 204, 146, 322	2, 096, 484, 225	2, 556, 583, 329	3, 103, 710, 410	3, 428, 937, 625
Total expenses	2, 212, 033, 156	2, 062, 288, 906	2, 517, 304, 623	3, 054, 326, 490	3, 377, 004, 485
Net gain or loss [2]	−7, 886, 834	+34, 195, 319	+39, 278, 706	+49, 383, 920	+51, 933, 140
Percentage of gain or loss to net worth [2]	−0. 84	+3. 71	+4. 45	+5. 79	+5. 84

[1] These figures represent the average of the total net worth of all reporting concerns at the beginning and end of their fiscal years.
[2] Plus (+) denotes gain, minus (−) denotes loss.

TABLE 15.—*Summary of consolidated balance sheets of 104 posted stockyards at close of year 1936* [1]

Assets	Amount	Liabilities	Amount
Current	$9, 058, 924	Current	$4, 184, 216
Fixed	141, 251, 556	Other	43, 186, 856
Other	10, 414, 694	Capital and surplus	113, 354, 102
Total	160, 725, 174	Total	160, 725, 174

[1] Reports from 2 yards were waived, 28 yards were posted too late for tabulation, and reports from 2 yards were not received.

A summary of consolidated profit and loss statements of 104 posted stockyards for the year 1936 [1] follows:

Income:	
Yardage	$10, 987, 194
Feed sales	7, 674, 029
Loading and unloading	1, 313, 653
Rent	1, 908, 654
Miscellaneous operations	8, 723, 224
Gross operating income	30,606,754
Expenses:	
Salaries and wages	6, 353, 685
Cost of sales—feed	9, 186, 647
Depreciation	1, 788, 881
Taxes (excluding Federal income tax)	1, 530, 805
Miscellaneous operating expenses	5, 566, 743
Total operating expenses	24, 426, 761
Net operating profit	6, 179, 993
Other income	435, 951
Total	6, 615, 944
Deductions from income	1, 592, 200
Net profit	5, 023, 744

[1] Reports from 2 yards were waived. 28 yards were posted too late for tabulation, and reports from 2 yards were not received.

TABLE 16.—*Summary of reports from stockyard companies subject to the Packers and Stockyards Act, 1932–36*

Item	1932 (80 concerns)	1933 (82 concerns)	1934 (92 concerns)	1935 (96 concerns)	1936 [1] (108 concerns)
Total average net worth	$120, 391, 889	$118, 196, 617	$117, 327, 650	$116, 068, 502	$113, 985, 320
Gross income	23, 812, 509	24, 649, 150	31, 728, 793	31, 264, 036	31, 042, 706
Net gain	4, 563, 510	5, 471. 264	6, 860, 729	4, 149, 287	5, 023, 744
Percentage of gain to net worth	3. 79	4. 63	5. 85	3. 57	4. 41

[1] Reports from 2 yards were waived, 28 yards were posted too late for tabulation, and reports from 2 yards were not received.

LIVESTOCK COMMISSION AGENCIES

Number and class of market agencies reporting in 1936 follow:

Old-line agencies	675
Cooperative agencies	51
Horse and mule agencies	14
Total	740

TABLE 17.—*Summary of consolidated operating statement of livestock commission agencies, 1934–36*

Item	1934 (705 agencies)	1935 (740 agencies)	1936 (740 agencies)
Total commissions earned	[1] $18,701,543	[2] $17,164,661	[3] $18,787,713
Total expenses (exclusive of owners' salaries)	13,572,801	12,922,615	13,864,886
Net operating profit	5,128,742	4,242,046	4,922,827
Other income	671,145	970,686	667,041
Other expenses	38,680	42,478	33,635
Return to owners	[1] 5,761,207	[2] 5,170,254	[3] 5,556,233

[1] Does not include $190,108.83 impounded commissions reported.
[2] Does not include $197,033.41 impounded commissions reported.
[3] Does not include $84,434.08 impounded commissions reported.

TABLE 18.—*Summary of consolidated profit and loss statements of 833 traders on 53 markets for 1936* [1]

Item	Dockage [2]	Animals handled	Weight	Amount
Cattle:				
618 traders on 46 markets:	*Pounds*	*Number*	*Pounds*	*Dollars*
Selling data		3,920,611	2,459,512,952	136,468,944
Cost data		3,921,312	2,446,373,234	131,269,107
Sheep:				
86 traders on 34 markets:				
Selling data		1,531,010	120,471,645	9,627,683
Cost data		1,532,507	120,112,058	9,188,455
Horses and mules:				
10 traders on 6 markets:				
Selling data		30,568		3,741,162
Cost data		30,568		3,430,843
Hogs:				
209 traders on 44 markets:				
Selling data	2,156,598	4,934,872	1,091,149,178	103,085,490
Cost data	2,465,045	4,935,207	1,083,709,032	101,270,701
All species:				
833 traders on 53 markets:				
Selling price				252,923,279
Cost price				245,159,106
Gross trading profit				7,764,173
Clearance commissions received				83,896
Other income				220,699
Total earnings				8,068,768
Expenses:				
Salaries and wages (other than owners')				1,393,599
Clearance commissions paid				608,821
Feed				1,552,892
Yardage				197,191
Other expenses				1,330,054
Total expenses				5,082,557
Return to owners				2,986,211

[1] Does not include traders who were engaged also in order-buying business. Some of the traders handled more than 1 species.
[2] Represents deduction in weight at time of sale because of quality or condition of the animal. This practice applies only to hogs.

CONTROL OF INTERSTATE TRANSPORTATION OF LIVESTOCK

In the supervision of the interstate transportation of livestock to prevent the spread of animal diseases, Bureau inspectors at 50 stockyards in 48 cities in

spected 20,784,182 cattle and 23,204,503 sheep, of which 5,138 cattle and 563,042 sheep were dipped under supervision to comply with the regulations of the Department and the various States to which they were destined. The number of swine inspected was 24,219,257, of which 250,390 were immunized and disinfected against hog cholera under Bureau supervision for distribution for feeding and breeding purposes.

Efforts were continued to minimize losses among stocker and feeder cattle and sheep on account of infectious disease. Divisions of public stockyards in which such livestock were handled were cleaned and disinfected under Bureau supervision.

There were received at the Bureau stations during the year 2,140 cars carrying animals affected with communicable diseases. Under Department regulations or on request of Canadian Government, State, and railroad officials, 6,780 cars were cleaned and disinfected under the supervision of Bureau employees.

Experienced veterinary inspectors at public stockyards continued to give particular attention to the inspection of all ruminants and swine for foot-and-mouth disease, no case of which was found.

Bureau employees at public stockyards devoted much time expediting the movement of reactors to the tests for Bang's disease and tuberculosis through the yards to slaughtering establishments.

ENFORCEMENT OF TRANSPORTATION AND QUARANTINE LAWS

In the administration of the 28-hour law many improvements were made in the facilities for feeding, watering, and resting livestock while in transit; 337 alleged violations of the 28-hour law were reported to the Bureau. The Bureau transmitted 287 apparent violations to the Solicitor for presentation to the Attorney General. Penalties amounting to $19,600 were imposed in cases decided in favor of the Government. Five employees devoted most of their time to this work, but the evidence was collected and the reports prepared largely by employees stationed at public stockyards whose time was devoted chiefly to other lines of work.

Thirty-four alleged violations of the quarantine laws were reported to the Bureau, and 22 cases of alleged violations were reported to the Solicitor for prosecution. In cases decided in favor of the Government, fines imposed amounted to $2,965.

PATHOLOGICAL DIVISION

Under the direction of Harry W. Schoening, chief, the Pathological Division has followed the usual line of scientific investigation of the diseases of domestic animals and birds, the poisoning of livestock by plants, and the examination of viruses, serums, and other biological products used in the treatment and prevention of diseases of domestic animals.

DIAGNOSIS AND CONTROL OF DISEASE

Cooperative work for the control and eradication of glanders in the various States was continued. The complement-fixation test was applied to 92 samples of blood serum from animals suspected of being affected with or exposed to the disease. Only two positive reactions were obtained.

Samples of blood serum from 549 horses in districts where dourine is present or suspected were subjected to the complement-fixation test, and 2 gave positive reactions. Blood serums from 26 horses, donkeys, and other animals offered for import were tested by complement fixation for glanders and trypanosomiasis before being admitted. No positive reactions were obtained.

Sixty-six brain specimens from suspected cases of rabies were received and subjected to laboratory examination. Of these, 50 were from dogs, 10 from cats, 1 from a mule, 2 from cattle, and 3 from rabbits. One dog from Maryland was found to be positive for rabies; the remaining specimens were negative. During the last 5 years only one definitely positive case of rabies has been found in the District of Columbia, this case occurring in 1934 in a dog brought into the District from Texas.

During the year 136 stock cultures were carried in the Division's collection, and 175 subcultures were supplied to various laboratories for use in the preparation of biologics and scientific investigation.

TESTING BIOLOGICAL PRODUCTS

In cooperation with the Division of Virus-Serum Control in the enforcement of the Virus-Serum-Toxin Act, the Pathological Division continued the examination of samples of biological products, cultures, and viruses intended for use in making such products. During the year 41 representative samples of serums, vaccines, bacterins, aggressins, filtrates, toxoids, and antitoxins were tested for purity, potency, and safety. Of these, 39 were approved and 2 were found to be unsatisfactory. Sixty-three cultures and viruses were examined for trueness to type, of which 35 were approved and 28 were found to be unsuitable for the preparation of veterinary biologics.

INFECTIOUS EQUINE ENCEPHALOMYELITIS AND CLINICALLY RELATED DISEASES

A survey of the 48 States revealed a material decrease in the incidence of infectious encephalomyelitis during the fiscal year. Although 8 States reported appreciable increases in the number of cases, 11 others reported material decreases. As contrasted with about 26,750 cases reported the previous year, only slightly more than 5,000 were reported during the current year.

Toxic encephalitis, a late fall and winter disease of the Midwest, attributed to the feeding of moldy and otherwise inferior corn, again caused more or less serious trouble.

Cross-immunity tests conducted in horses with the viruses of infectious encephalomyelitis and equine infectious anemia failed to reveal any immunological relationship between the two diseases.

An as yet unclassified disease of horses in areas of Colorado where encephalomyelitis epizootics had previously occurred, was investigated. At least three other Western States have experienced the disease under similar conditions. Inoculations of blood and other tissues from affected and recovered horses and mules into laboratory animals and horses gave no definite indication that the disease was infectious. The symptoms of the affection were those of an acute toxemia, with cerebral involvement. A constant symptom was extreme icterus, and usually there was no fever. Marked excitement and frenzy were sometimes observed. Pathologically, the chief lesions, principally in the liver, consisted of parenchymatous degeneration with focal necrosis and cellular infiltration. There appears to be a connection between the occurrence of this obscure disease and previous outbreaks of infectious encephalomyelitis, but whether the relationship of the two diseases is actual remains to be determined from further studies and attempts to produce the disease artificially. Investigations toward this end are under way.

During the year, several cases of a sporadic hemorrhagic encephalitis in horses were studied. The cause was not determined, although the disease appears to be distinct from either infectious encephalomyelitis or moldy-corn poisoning.

EQUINE INFECTIOUS ANEMIA (SWAMP FEVER)

In a continuation of investigations on equine infectious anemia, commonly known as swamp fever, further efforts were made to utilize the complement-fixation test for its diagnosis. Distilled water extracts of heart muscle, bone marrow, and body and visceral lymph glands from acute cases were tested for possible antigenic value. No appreciable antigenic properties were found in any of these preparations except those made from the splenic and mesenteric lymph glands, and these were definitely inferior to antigens made from the splenic pulp, as previously reported. Urine from affected horses had no antigenic properties. Emulsions of strongylids and cylicostomes taken from infected horses had no antigenic value. Spleen tissue taken from an infected horse and preserved in glycerin phosphate solution for 1½ years still possessed good antigenic properties.

During the year, 64 spleens taken from horses dead of swamp fever were tested for antigenic value, and 59 reacted positively with known complement-binding swamp fever serum. The remaining five were negative.

Good spleen antigens when kept in a frozen state were found to retain their specific properties and not become anticomplementary over a period of many months. Although the work with the complement-fixation test is encouraging, the technique has not been developed to a point where it has practical use.

Two natural infection cases of swamp fever, in addition to those previously reported, were detected by the complement-fixation test, in that the spleens of these animals at autopsy reacted positively with known complement-binding swamp-fever serum. The serums from these animals, however, gave no reaction with proved swamp-fever antigens. The diagnosis made on the basis of the complement-fixation test was in both instances confirmed by horse inoculations.

Two provocative tests reported to be means of determining whether an animal is suffering from swamp fever in an inactive or inapparent form were tried. One test consisted in injecting a liter of sterile beef infusion broth intravenously into the suspected animal; the other consisted in copious blood letting, that is, bleeding 6 to 8 liters at one time. With either test the subject, if infected, was supposed promptly to exhibit the symptoms of an acute swamp-fever reaction. Five horses known to be infected but showing no clinical symptoms were subjected to the above provocative tests. In no instance, however, did an acute reaction result from the procedure.

Transmission of swamp fever from infected horses and mules to normal horses and mules by intimate stable contact was effected in one test in which precautions to exclude insects as possible vectors were taken. A period of 6 months of contact was required to transmit the infection.

Filtered saliva and filtered urine collected from horses affected with acute swamp fever, injected into normal horses, did not reproduce the disease. Large quantities of unfiltered saliva and unfiltered urine from a horse affected with acute swamp fever given to normal horses orally did not reproduce the disease.

A saline-solution extract of washed *Strongylus* spp. taken from a horse infected with swamp fever and injected into a normal horse reproduced the disease in the latter. A similar extract prepared from washed cylicostomes from the same infected horse, injected into a normal horse, failed to reproduce the disease in the latter. The combined last washing from both the *Strongylus* spp. and the cylicostomes injected into a normal horse did not reproduce the disease. These tests, which were conducted cooperatively with the Zoological Division, indicate that the virus of swamp fever was present within the bodies of the *Strongylus* spp. but not in the cylicostomes. Tests are in progress to determine whether *Strongylus* spp. obtained from a swamp fever-infected horse will pass the virus of swamp fever through the egg to the larvae that develop therefrom and in this manner act as vectors of swamp fever.

Further attempts were made to find laboratory test animals susceptible to the virus of swamp fever. These were unsuccessful. A number of tissue vaccines, additional to those previously reported, were prepared and tested during the year, as follows: Formolized brain tissue, formolized spleen tissue, chloroform brain tissue, crystal-violet spleen tissue, crystal-violet blood, chemically treated blood, and heat-treated blood products. None of these immunized normal horses to experimental exposures to swamp fever.

Efforts were continued to find a specific medicinal agent that would be of value in curing swamp fever. In addition to those preparations previously reported, the following preparations were tested on both chronic and acute swamp-fever infections: Sodium cacodylate, hydrochloric acid, formin, potassium permanganate, and fuadin. None of these had any favorable influence on the course of the acute form of the disease. Neither did any free the infected animals of the virus.

In connection with the safeguarding of veterinary biologics prepared from horse tissues or horse blood from possible contamination with the virus of swamp fever, the effects on the virus of pasteurization temperatures and chemicals commonly used in the preparation of biologics were found to be as follows:

The virus of swamp fever in horse serum was destroyed by pasteurization at temperatures ranging between 57° and 60° C. for 1 hour. The virus was not destroyed by exposure to these temperatures for one-half hour. The virus in horse serum was destroyed by the action of 0.5 percent phenol or 0.5 percent phenol together with 0.5 percent ether for 30 days at 5°; by 0.1 and 0.2 percent formalin for 33 days at 5°; by 0.1 percent crystal violet together with 0.05 percent phenol for 30 days at 5°; and by phenyl mercury acetate, 1 to 10,000, together with phenol, 1 to 400, for 30 days at 5°. The virus in horse serum was not destroyed by the action of 31.5 percent ammonium sulphate for 13 days at 5°; nor by merthiolate, 1 to 10,000, together with phenol, 1 to 400, for 30 days at 5°; nor by 0.25 percent phenol together with 0.25 percent ether for 60 days at 5°; nor by 0.35 percent phenol together with 0.35 percent ether for 60 days at 5°.

The virus in defibrinated horse blood was destroyed by the action of a mixture of crystal violet, 1 to 2,000, and phenol, 1 to 1,000, for 14 days at 37° C. followed by 48 days at 5°.

The virus in ground spleen tissue was destroyed by the action of a mixture of crystal violet, 1 to 2,000, and phenol, 1 to 1,000, for 62 days at 5° C., and in 10 percent aqueous emulsion of spleen tissue by 0.4 percent formalin for 90 days at 5°.

The virus in 10 percent aqueous horse-brain emulsion was destroyed by the action of 0.4 percent formalin for 30 days at 5° C., and in a 33 percent brain suspension by 1 percent chloroform for 90 days at 5°. The virus was not destroyed, however, by 0.4 percent formalin for 13 days at 5° or by 1 percent chloroform for 60 days at 5°.

SWINE ERYSIPELAS

Further studies of the relationship of the rough and smooth type cultures of *Erysipelothrix rhusiopathiae* to production of satisfactory antigens for the agglutination test for swine erysipelas revealed that special handling of the smooth cultures is necessary to keep them from reverting to rough cultures, which are unsuitable for antigen production. The best procedure found thus far for maintaining the smooth cultures is cultivation in Liebig's beef extract broth, pH 7.4, and subculturing every 24 hours.

Examinations of a number of cultures of *E. rhusiopathiae* on primary isolation from animal tissues showed that the organism as it comes from the animal is practically always the smooth type regardless of whether the organism was recovered from the tissues of an acute case or from the tonsils or joints of the chronic form of the disease. One exception was noted in the instance of a chronic arthritic infection in an adult boar, in which smooth cultures were recovered from two joints and a rough culture was recovered from a third joint of the same animal. The smooth cultures were virulent whereas the rough culture was avirulent.

Examination of the tonsils from a number of slaughtered swine from a herd in which a low-grade arthritic form of erysipelas was prevalent, revealed that erysipelas infection in the tonsils was common in this herd. The tonsils of 63 hogs were examined for swine erysipelas organisms, and blood samples from these hogs drawn at the time of slaughter were tested for erysipelas agglutination reaction. The swine erysipelas organism was found in 11 pairs of tonsils from this group of 15 reacting animals. Forty-eight serum samples gave a negative serum reaction, and of this group of 48 animals swine erysipelas organisms were found in the tonsils of 3.

During the year a herd of 30 brood sows and boars, all infected with swine erysipelas (chronic arthritic form), was established at the Bureau's Animal Disease Station at the National Agricultural Research Center, for the purpose of studying transmission of the disease and methods of control. More than 100 pigs from the spring farrowing are being raised for determinations of the above objectives.

Observation was made that certain strains of the *Erysipelothrix rhusiopathiae* can survive and even multiply in concentrations of phenol that are bacteriostatic or bacteriocidal to many other micro-organisms. By utilizing this information, a procedure was developed that has proved to be valuable for isolation of the swine erysipelas organism from specimens where rapidly growing contaminants preclude isolation by the ordinary laboratory procedures.

ANAPLASMOSIS

A vaccine consisting of 90 parts of defibrinated, virulent blood from a carrier cow, 10 parts of 1-percent aqueous solution of phenol, and 5 parts of 1-percent aqueous solution of crystal violet was held at a temperature of 37.5° C. for varying periods, before being tested on susceptible cattle. Part of the vaccine was incubated for 6 days, part for 9 days, and part for 16 days. A dose of 30 cc of the vaccine was injected subcutaneously into each of three cows so that the first animal received the product incubated for 6 days, the second, the product incubated for 9 days, and the third, the product incubated for 16 days. Three control animals likewise received 30 cc each of virulent blood incubated for 6, 9, and 16 days. Neither the vaccinated nor the control animals developed any symptoms of anaplasmosis, and the control animals later were shown to be susceptible to the disease. Incubation of virulent blood for 6, 9, and 16 days rendered the blood avirulent. Seventy days after injection of the 6-day vaccine,

the vaccinated cow and a control animal were injected with virulent blood. Both animals developed typical anaplasmosis. Four months after use of the 9- and 16-day vaccines, the vaccinated cattle and a control animal were inoculated with virulent blood. Both vaccinated and the control animals reacted positively to anaplasmosis. It was concluded that the vaccine thus prepared afforded no protection and did not contain any living anaplasms.

Calves less than 6 months of age and often those up to 1 year of age, as a general rule, develop no symptoms—thermic, parasitic, or otherwise—following injection with virulent blood. However, if such animals are subjected to splenectomy several months or more after inoculation with virulent blood, they develop acute symptoms of the disease. It was found that calves from 1 to 3 months of age became very susceptible to anaplasmosis following splenectomy, with marked symptoms of fever and anemia and with a high percentage of their erythrocytes containing marginal bodies. Several splenectomized calves, after apparent clinical recovery from the disease, continued to show marginal bodies in the red cells for months. These young splenectomized calves have proved to be very economical and reliable test animals for anaplasmosis. The splenectomy is done under general anaesthesia, induced either by intravenous injection of chloral hydrate solution or nembutal.

One cow which developed acute anaplasmosis in August 1927, as a result of experimental inoculation, is still an active carrier of *Anaplasma marginale* after nearly 10 years. Another cow infected at the same time in 1927 lost the carrier state after about 5 years as shown by actual inoculation test of her blood on several occasions in subsequent years. Defibrinated blood from this latter cow was injected subcutaneously into a susceptible cow in doses varying from 75 to 150 cc at about weekly intervals until about 800 cc of blood had been administered. After a 3-week interval an additional 150 cc of the blood was injected, and at the same time 30 cc of blood from a carrier cow was injected subcutaneously. The treated animal reacted typically to anaplasmosis, thus showing that the recovered carrier's blood contained no protective substances. The results of experiments thus far undertaken confirm the general belief that the state of premunition is necessary to insure resistance against anaplasmosis.

MISCELLANEOUS DISEASES

An organism culturally and pathogenically identical with *Corynebacterium ovis*, the cause of caseous lymphadenitis or pseudotuberculosis in sheep, was isolated from affected tissues of a case of multiple abscessation of the lung and other tissues in a wild, western deer. Previous reports, without bacteriological confirmation, suggest that the disease may exist, to an appreciable extent, in the deer of some mountain areas ranged by sheep.

Comparative studies of actinomycosis, caused by *Actinomyces bovis*, and actinobacillosis, due to *Actinobacillus lignieresi*, were initiated. As previously reported by other investigators, both in the United States and abroad, the lesions in the two diseases were found to be generally indistinguishable to the naked eye, except that actinomycosis was observed to affect the bone primarily, whereas actinobacillosis affected the soft tissues such as lymph nodes and the musculature of the tongue, in the cases studied. Microscopically, the pathology of the two diseases was essentially identical except in some smears and sections in which the Gram stain was effective for the purpose of differentiation. The exact nature of the process present was found, in the lesions studies, to be best determined by cultural means. An interesting case of actinomycosis, in which the portal of entry of the infection appeared to be the nares, was observed.

During the year, 16 cases of suspected tuberculosis of sheep were received, for examination, from establishments operating under Federal meat inspection. Acid-fast organisms were found in 15 of these cases. Animal inoculations indicate that in all these cases the causative organism was the avian type of tubercle bacillus.

Potency studies of rabies vaccines in rabbits were continued, using the intralingual method for exposure of vaccinated animals to the virus. This method of producing rabies has been successful and appears to be a suitable procedure for testing the potency of vaccines. A comparative potency test of three lots of vaccine was made on rabbits. One lot was prepared with chloroform and two with phenol, one of the latter being incubated at 37° C. for 48 hours in the presence of 1 percent phenol and the other being held at

ice-box temperature. Satisfactory protection was obtained with the chloroform-treated vaccine and the phenol vaccine held at ice-box temperature. The protective value of the phenol-treated vaccine held at incubator temperature was considerably less than that of the other two vaccines. A comparison of the protective value of a vaccine when injected subcutaneously in one group of rabbits and intraperitoneally in a second group of rabbits was also made. The intraperitoneal injection of the vaccine afforded much greater protection than the subcutaneous injection of the same vaccine. This work was limited to one experiment involving 18 rabbits.

For the control of paratuberculosis, there were produced during the year 1,220 cc of intradermic johnin for the use of Bureau veterinarians in testing cattle in suspected herds and also cattle for export to some foreign countries. The production of johnin is still in an experimental stage. Studies are being continued on the various methods of johnin production.

Of 381 commercially prepared whole-blood, stained, pullorum-disease antigens examined in connection with the national poultry improvement plan, 60 specimens were disapproved and the remaining 321 found to be satisfactory.

Reports of an unusually high percentage of pullorum-disease agglutination reactions allegedly caused by the excessive feeding of fowls on grasshoppers in a limited territorial area were investigated. Forty-seven representative fowls that had given positive reactions were purchased from five representative poultry flocks in the above-mentioned area and necropsied. Eighty percent of them revealed pullorum-disease infection, and no experimental evidence was developed which would support the theory that the consumption of grasshoppers by the birds had in any way influenced the results of the agglutination test for pullorum disease.

In an outbreak of chronic fowl cholera the Bureau applied a stained-antigen, rapid, whole-blood test for *Pasteurella avicida* infection, and a number of positive reactions were obtained. The removal of the reactors resulted in the complete disappearance of the trouble. After an acute outbreak in another flock had subsided, the agglutination test was applied to a representative group of birds in this flock and no positive reactions were obtained.

An epizootic of arthritis (wing lameness) in several flocks of pigeons was investigated. *Salmonella aertrycke* was found to be the cause of the trouble. Some evidence was developed that carriers of this condition could be diagnosed by means of a stained-antigen, rapid, whole-blood test, using an antigen prepared from *S. aertrycke.*

INVESTIGATIONS OF STOCK-POISONING PLANTS

As a result of further study of bighead in sheep, evidence was obtained to indicate that the type of feed eaten by sheep is a predisposing factor in the cause of bighead by littleleaf horsebrush (*Tetradymia glabrata*). Although the larkspur *Delphinium occidentale* was known to be very much less toxic than *D. barbeyi*, feedings made early in the season showed that cattle might easily be poisoned by young growth of *D. occidentale.* The roots of false hellebore (*Veratrum californicum*) contain most of the toxic element. Syrian rue (*Peganum harmala*) was shown to be poisonous to cattle. A groundsel (*Senecio spartioides*) when fed to horses proved to be much more toxic in its young stages than when more mature. Rayless goldenrod (*Aplopappus heterophyllus*) may lose its toxicity very rapidly when stored dry. Cattle have been experimentally poisoned by copperweed (*Oxytenia acerosa*).

TOXICOLOGICAL INVESTIGATIONS

A comprehensive project was begun to investigate the development of hydrocyanic acid in forage plants and the conditions under which livestock may be poisoned by them. During the year studies of arrowgrass, Johnson grass, Sudan grass, sorghums, and wild cherries were conducted with material originating in eight States and growing under widely different conditions of climate, soil, and available water. Considerable progress was made and numerous data were collected. A method for the preservation of samples of cyanogenetic plants for analysis was worked out whereby the number of samples that can be handled may be greatly increased and material can be stored for long periods without change. The method is conducive to accuracy in results although the samples are collected many thousands of miles away from the laboratory and several days elapse before they can be analyzed. A paper on the method of preservation was prepared for publication.

Investigations of the toxic alkaloids of lupines were continued. Several new species were obtained and preliminary work on them was done. Papers on the alkaloids of *Lupinus laxus*, *L. barbiger*, and *L. caudatus* were prepared.

BRANCH LABORATORIES

BELTSVILLE

In bovine-mastitis investigations the study, previously reported, of the incidence and types of streptococci present in the colostrum of first-calf heifers was continued. The colostrum from 64 animals was examined, and streptococci were found in samples from one or more quarters of the udders of 13 heifers in the first examination. *Streptococcus agalactiae* was present in three samples from two of these animals. When a second examination was made on the milk or colostrum from these 13 heifers 5 days to 3 weeks later, no streptococci were recovered in 10 animals. In one of these, *S. agalactiae* had previously been found. Of the three remaining animals, one was found to be free from streptococci at a third examination, whereas *S. agalactiae* persisted in a second one, and the third animal had become infected with this species 3 weeks after parturition following its introduction into the milking line. Since this investigation was begun, 164 heifers have been examined and only two animals in which *S. agalactiae* was present in the first examination continued to carry this species in subsequent examinations. This finding indicates that first-calf heifers may be added to groups of cows free from mastitis due to *S. agalactiae* with slight danger of introducing this type of infection.

A further study of the efficacy and interpretation of the Hotis test for detecting mastitis streptococci in milk was made. This test was announced in Circular No. 400 issued in August 1936. Altogether, 2,663 additional milk samples were tested. Of this number, 1,995 samples were negative to the Hotis test and to microscopic examination of incubated milk smears. Of the remaining 668 samples, 646 were positive to either or both tests. Of these, 591 samples were positive to both tests, 46 samples were positive to microscopic examination of incubated milk smears but negative to the Hotis test, and 9 were negative to the microscopic examination of incubated milk smears but positive to the Hotis test. Twenty-two samples gave suspicious reactions to the examination of incubated milk smears and were negative to the Hotis test. It appears from these results that the Hotis test has a high degree of efficacy in the detection of animals harboring *S. agalactiae*.

A survey was carried out to correlate the physical condition of the udder, as judged by palpation, with the presence of streptococci in the milk. Altogether, 697 cows were examined and 310, or 44.5 percent, were found to have streptococci in one or more quarters. Of the cows carrying streptococci, 27.7 percent were found to have marked physical evidence of mastitis in one or more quarters. In the remaining 387 cows, which were free from streptococci, 12.8 percent showed marked physical evidence of mastitis. Although the incidence of physical evidence of mastitis in cows carrying streptococci is higher than in those in which streptococci were not present, it is evident that physical evidence of mastitis may be present in streptococci-free herds. Accordingly, physical evidence of mastitis does not necessarily indicate that an animal is affected with streptococcic mastitis.

During the year, a herd of 10 first-calf heifers was established at the Animal Disease Station to study the effect of lactation on the physical condition of the udder and the composition of the milk. No bacteria which are known to be capable of causing mastitis were found in the udders of these animals. Certain changes in the chemical composition of the milk and in the physical condition of the udders were noted in a number of heifers. However, this work has not been carried far enough to permit definite conclusions to be drawn.

The efficacy of sanitary measures for controlling the spread of streptococcic mastitis in dairy herds has been the subject of continued investigation. During the year an opportunity was afforded in one large herd to keep in a separate barn 50 lactating animals entirely free of streptococcic-mastitis infection. With this complete segregation, no cases of infection with *S. agalactiae* appeared in the clean herd up to the end of the fiscal year, a period of 7 months. Likewise, in another herd of 20 lactating animals in which all cows carrying *S. agalactiae* in the udders had been removed, no cases of infection with this species of streptococci were found in a 3-year period. All replacements in this herd were made from first-calf heifers raised on the premises.

In the poultry investigations during the year, 184 birds were necropsied. In a group of 16 pullorum-reacting fowls, results from the whole-blood, rapid test and the tube test were in 87.5-percent agreement; those from the whole-blood, rapid test and from necropsy were in 75-percent agreement; and those from the tube test and from necropsy were in 75-percent agreement. Of 3,174 pullets kept in the normal flock, 0.3 percent reacted to the pullorum test. Of 99 birds used by the Zoological Division, 6 reacted to the test. Of 245 turkeys in the breeding flock, 8 birds reacted to the tuberculin test, and in 7 of the reactors which were necropsied lesions of tuberculosis were observed in 6.

An experiment on the transmission of fowl paralysis, which was a continuation of work of the previous year, was interrupted by a virulent respiratory disease which required for its control the destruction of all the exposed birds.

In past experiments the frequent occurrence of spontaneous cases of fowl paralysis confused the results of the experiments. As an example, in one experiment, 27.9 percent of the controls developed spontaneous fowl paralysis. In order to obviate this difficulty, an experiment was begun to determine whether chicks from apparently paralysis-free stock can be raised to sexual maturity without developing any cases of spontaneous fowl paralysis under the conditions of environment prevailing at the branch pathological laboratory at Beltsville, and with no known paralysis virus present on the premises. To the end of the fiscal year, during a period of 4 months, no paralysis appeared in any group of chicks in this experiment.

CHICAGO

The branch pathological laboratory at Chicago, Ill., was engaged, as in previous years, in investigating diseases of meat food animals and aiding the Federal meat-inspection service by rendering diagnoses of obscure or unusual diseases and conditions.

The following unusual cases were encountered and studied: Three cases of neurofibromatosis in the heart of cattle, a neurogenic sarcoma in the gluteal region of a cow with metastases in the lungs, and fibrochondroma in the lungs of an aged cow, rabies in a calf, a hypernephroma of the kidney of a cow, anthrax in swine, a papillary cystadenoma in the mammary glands of a sow, and diffuse suppurative osteomyelitis of hogs. Although malignant tumors in sheep are rather infrequently reported in the literature, during the year eight cases of carcinomatosis involving the lungs, liver, and associated lymph glands were encountered. Two types of adrenal tumors of cattle were studied, one a cortical adenoma springing from epithelial elements of the cortex and the other belonging to the group of pheochromocytoma and originating in the chromaffin cells of the medulla. Differentiation of the two tumors was accomplished by treating the fresh tissues in a strong solution of potassium bichromate to which 10-percent formalin was added. The cells of the medullary tumors absorb the chromium salt and become dark in color, whereas the cortical tumor cells do not thus react and show no color change.

Studies of actinomycotic lesions in cattle were made of numerous specimens from maxillae, lymph glands, tongue, and other tissues. The ray fungus, *Actinomyces bovis*, was found to be the causative agent of lesions of bony structure, whereas *Actinobacillus lignieresi* was encountered only in lesions of the soft tissues. These findings are in agreement with those of other investigators. A case of polycystic kidneys in a pig was studied. The condition, consisting of numerous small cysts uniformly distributed throughout the kidneys, is of congenital origin arising from faulty union of the medulla and cortex. The cysts tend to increase in size, causing the gradual atrophy of the normal kidney cells with consequent loss of kidney formation, which results in eventual death of the animal from uremia. Studies of the gross and microscopic structure of the intestines of pigs in which only mesenteric lymph glands were involved in a tuberculous process resulted in finding no evidence of tuberculosis in the intestinal wall.

DENVER

During the year 3,737 specimens were examined at the Denver, Colo., laboratory. Of 1,616 serum samples from cattle tested for Bang's disease, 91.9 percent were negative, 6.6 percent positive, and 1.5 percent suspicious, according to agglutination tests made in this laboratory. Of 1,004 chickens examined, 223 were found to be affected with pullorum disease, 128 with range paralysis, 41 with coccidiosis, and 33 with trichomoniasis. Of 360 turkeys examined,

trichomoniasis was found in 63, unhealed navels in 51, blackhead in 28, and coccidiosis in 14. Of 67 silver foxes examined, paratyphoid infection was determined in 9. A considerable number of specimen tissues taken from cattle affected with coccidioidal granuloma were received for examination. This disease, which is a serious and often fatal disease of man, is a rather benign affection of cattle involving usually only the bronchial and mediastinal lymph nodes. In several of the cases studied this year definite lesions were demonstrated in the lungs, a finding not heretofore reported.

DIVISION OF TICK ERADICATION AND SPECIAL DISEASES

The Division of Tick Eradication and Special Diseases, under the direction of W. M. MacKellar, chief, conducted the Bureau's cooperative work in the eradication of the cattle-fever tick and in hog-cholera control.

TICK ERADICATION

The eradication of the cattle-fever tick was continued in cooperation with State and county officials and cattle owners of the South, and during the year a systematic campaign against the cattle-fever tick was begun in the Territory of Puerto Rico.

At the close of the fiscal year, 260 veterinarians and other Bureau employees were working in cooperation with 679 State and 13 county employees engaged in this project. In addition to these regular employees, other workers furnished under the provisions of the Emergency Relief Appropriation Act were also engaged in the various activities connected with this project. The number of these additional workers varied during the year, but at the peak of employment was 1,879. With this assistance and under the supervision of the regular employees, 25,413,494 inspections or dippings of cattle, and 3,305,782 inspections or dippings of horses and mules, were conducted. More than 13,442 dipping vats were used in the official dippings.

The following areas were released from Federal quarantine as a result of tick-eradication activities: Two counties in Florida, 22 parishes and the remainder of 2 parishes in Louisiana, and 8 counties and parts of 2 counties in Texas. The aggregate area of this released territory is 28,150 square miles. At the close of the fiscal year the area remaining under Federal quarantine in continental United States had been reduced to 5 percent of its original size and is now confined to parts of Florida and Texas. The release of the final areas in Louisiana made that State the thirteenth to gain freedom from the Federal tick quarantine. No areas were requarantined during the year. Table 19 shows the progress made in tick eradication since its beginning in 1906 and gives the status of the work at the close of the fiscal year.

TABLE 19.—*Tick-eradication results, July 1, 1906, to June 30, 1937*

State	Counties quarantined on—		Counties released to June 30, 1937	Released counties tick-free on Nov. 1—			
	July 1, 1906	June 30, 1937		1933	1934	1935	1936
Alabama	67	0	67	66	67	67	67
Arkansas	75	0	75	64	63	68	70
California	15	0	15	15	15	15	14
Florida	67	6	61	44	48	55	58
Georgia	158	0	158	158	158	155	158
Kentucky	2	0	2	2	2	2	2
Louisiana	64	0	64	14	16	24	29
Mississippi	82	0	82	79	74	77	79
Missouri	4	0	4	4	4	4	4
North Carolina	73	0	73	73	73	73	73
Oklahoma	61	0	61	60	61	61	61
South Carolina	46	0	46	46	46	46	46
Tennessee	42	0	42	42	42	42	42
Texas	198	28	170	135	130	127	137
Virginia	31	0	31	31	31	31	31
Total	985	34	951	833	830	847	871

DEER A PROBLEM IN FLORIDA

For several years it has been apparent to cooperating authorities in Florida that the completion of the project in that State would depend on the application of proper control measures to deer which are perpetuating the fever tick (*Boophilus annulatus* var. *australis*) in several large game preserves. To provide the necessary measures permitting the removal of the deer from these areas, special State legislation was needed. This was recommended by the Florida Livestock Sanitary Board and endorsed by interested cattle owners of the State. In compliance with this request, the 1937 Florida Legislature enacted laws providing for the necessary reduction in the number of deer ranging on game preserves in four of the six counties in which the tick-infested game preserves are located. If carried out this action, it is believed, will make possible the prompt completion of the work in the four counties. However, the problem will continue in the two remaining counties until legal provisions are made for disposing of the infested deer.

EMERGENCY RELIEF ASSISTANCE

During the year tick eradication in the States of Florida, Louisiana, and Texas, and the Territory of Puerto Rico was again greatly helped by the allotment of funds made under the provisions of the Emergency Relief Appropriation Act. This assistance was given through the Works Progress Administration and the Puerto Rico Reconstruction Administration. Workers from these sources were employed for approximately 1,280,662 man-hours in the various activities connected with the project. It was largely due to this assistance that Louisiana was able to conduct the systematic campaign in all its remaining quarantined area, which resulted in that State's release from Federal quarantine on December 1, 1936. Such assistance also made it possible for Florida thoroughly to reinspect and check conditions regarding tick infestation in much of the released area of that State. In Texas the assistance made possible the construction of the dipping equipment needed in 14 quarantined counties, thus providing for the beginning, in April 1937, of systematic tick-eradication work in that area—the last inactive tick-infested area of the South. In Puerto Rico dipping equipment was furnished for the western third of the island, and tick-eradication work was undertaken in that area.

MOVEMENT FROM QUARANTINED AREAS

In the enforcement of Department regulations governing the interstate movement of cattle and horses from the areas quarantined for splenetic or tick fever, 120,451 cattle were inspected, or dipped and inspected, for which 4,136 certificates were issued authorizing their interstate movement as noninfectious. Horses and mules to the number of 9,123 were also inspected in the quarantined areas, and 1,319 certificates were issued authorizing their movement from such areas. In connection with these movements, 382 cars were cleaned and disinfected.

HOG-CHOLERA CONTROL

During the year 30 veterinarians, except while assigned to other emergency duties, were employed in investigating and controlling outbreaks of hog cholera and allied swine diseases. Through visits to farms and attendance at meetings the Bureau veterinarians had an opportunity for 51,867 farm inspections and consultations relating to their work with farmers, veterinarians, State officials, and others interested in the suppression of hog cholera.

Educational work on this project was continued by the veterinarians, who attended 260 meetings, at which there was an attendance of 28,077 persons. Particular attention was given to the importance of correct diagnosis of swine diseases, careful immunization, and better sanitation. Demonstrations in the use and efficacy of the serum treatment were given in the treatment of 33,115 hogs. During the year 3,522 outbreaks of cholera were reported to Bureau veterinarians, an increase of 190 outbreaks over the previous year. Table 20 summarizes the activities of the year.

TABLE 20.—*Summary of hog-cholera-control work, fiscal year 1937*

State	Meetings		Farm inspections and consultations	Post-mortem examinations	Hogs treated in demonstrations	Outbreaks reported to Bureau veterinarians
	Number	Attendance				
Alabama	13	387	2,674	106	66	94
Florida	7	855	2,391	28	14,269	56
Georgia	1	60	693	42	485	62
Illinois	20	3,730	6,848	753	0	474
Indiana	5	570	1,678	47	0	159
Iowa	44	3,704	5,693	313	0	458
Kansas	2	52	870	25	0	40
Kentucky	20	589	5,378	189	261	132
Louisiana	1	35	487	16	2,075	76
Maryland	26	3,933	4,274	131	706	121
Michigan	0	0	164	14	113	148
Mississippi	13	419	1,678	17	12	3
Missouri	0	0	0	0	0	0
Nebraska	1	25	491	105	0	35
North Carolina	46	5,525	1,807	62	5,533	45
Ohio	7	970	1,131	136	0	287
Oklahoma	16	4,354	2,844	28	0	89
Oregon	2	35	440	30	0	37
South Carolina	7	331	1,566	26	9,102	172
South Dakota	0	0	0	0	0	0
Tennessee	11	334	2,712	122	198	737
Texas	2	31	2,669	36	0	234
Virginia	11	1,680	4,176	57	25	9
Washington	1	50	539	42	0	14
Wisconsin	4	408	664	53	270	40
Total	260	28,077	51,867	2,378	33,115	3,522

TUBERCULOSIS ERADICATION DIVISION

The work of eradicating tuberculosis from livestock was continued in cooperation with States, counties, and livestock owners. It was possible to conduct a large volume of work in connection with the tuberculin testing of cattle during the year, because of the addition of Federal emergency funds provided for it. Activities for the elimination of Bang's disease and Johne's disease likewise were conducted on a cooperative basis. The work of the Division was directed by A. E. Wight, chief, and his assistants.

BOVINE TUBERCULOSIS

Most of the work done during the year consisted in the testing of cattle under the area plan. Altogether, 13,750,308 tuberculin tests were applied to cattle. The percentage of reactors was 0.7, the same as last year, which was the lowest degree of infection found throughout the project, which began in 1917.

The Federal force of veterinarians was engaged to a considerable extent in supervising the field work performed by a large number of veterinarians employed with emergency funds. The work was conducted from 44 field stations. The State and Territorial authorities employed an average of about 265 veterinarians throughout the year; counties employed about 253 veterinarians on full time. An average of 394 emergency veterinarians were employed during the year, including those working at a per-diem rate, on a part-time basis, and 143 local helpers were employed to assist them in the field work.

During the year emergency funds for the cattle tuberculosis work amounted to approximately $2,700,000. This sum was used for both operating expenses and indemnities. The Federal indemnity payment with these emergency funds could be made to owners without requiring a similar or any payment from the cooperating States, Territories, or counties. The regular Federal appropriation for tuberculosis work during the year was $1,500,000, of which $396,884 was for indemnities and the remainder for necessary operating expenses. The combined State, Territorial, and county appropriations were approximately $4,500,000 during that period. The maximum Federal payment for grade cattle was $25 and for purebred registered cattle $50. The average appraised value of reactors was $86.04. Of the total number of reactors on which Federal payment was made, 5 percent were purebred registered cattle. The average Federal payment was $22.72 and the average State payment $12.20. Of the Federal funds, about $1,730,000 was used for indemnity purposes, and the State funds for indemnity amounted to about $1,000,000.

At the end of the year 6,745,471 herds, containing 61,640,711 cattle, were under supervision for the eradication of tuberculosis. Table 21 shows that from 1917 to 1937, inclusive, 3,562,161 reactors were removed from the cattle herds of this country.

TABLE 21.—*Tuberculin testing under accredited-herd and area plans, 1917–37*

Year ended June 30—	Cattle tested					Modified accredited counties	Yearly increase of—		
	Accredited-herd plan	Area plan	Total	Reactors found and removed			Herds accredited [1]	Herds passed 1 test [1]	Herds under supervision [1]
	Number	*Number*	*Number*	*Number*	*Pct.*	*Number*	*Number*	*Number*	*Number*
1917	20,101	----------	20,101	645	3.2	--------	--------	--------	--------
1918	134,143	----------	134,143	6,544	4.9	--------	204	883	--------
1919	329,878	----------	329,878	13,528	4.1	--------	578	5,652	--------
1920	700,670	----------	700,670	28,709	4.1	--------	2,588	10,064	--------
1921	1,366,358	----------	1,366,358	53,768	3.9	--------	4,831	33,215	71,806
1922	1,722,209	[2] 662,027	2,384,236	82,569	3.5	--------	8,015	111,719	140,376
1923	1,695,662	1,765,187	3,460,849	113,844	3.3	--------	12,310	150,748	187,915
1924	1,865,863	3,446,501	3,312,364	171,559	3.2	38	19,747	216,737	305,809
1925	2,008,526	4,991,502	7,000,028	214,491	3.1	51	24,110	392,740	414,620
1926	1,989,048	6,661,732	8,650,780	323,084	3.7	109	24,009	382,674	435,840
1927	2,522,791	7,177,385	9,700,176	285,361	2.9	149	34,084	229,086	261,148
1928	2,589,844	8,691,646	11,281,490	262,113	2.3	180	38,880	427,595	473,218
1929	2,853,633	8,830,087	11,683,720	206,764	1.8	213	1,639	249,420	281,323
1930	2,953,350	9,892,521	12,845,871	216,932	1.7	236	11,863	227,921	347,448
1931	3,086,403	10,695,870	13,782,273	203,778	1.5	247	[3] 26,259	350,735	356,916
1932	3,131,426	10,312,131	13,443,557	254,785	1.9	220	18,049	262,988	303,832
1933	2,980,526	10,093,368	13,073,894	255,096	2.0	183	19,701	337,730	346,394
1934	2,826,257	12,293,506	15,119,763	232,368	1.5	189	31,460	342,262	387,969
1935	2,716,292	22,521,240	25,237,532	376,623	1.5	613	13,128	1,324,643	1,276,249
1936	2,193,015	20,725,023	22,918,038	165,496	.7	493	17,119	998,703	924,410
1937	2,274,337	11,475,971	13,750,308	94,104	.7	109	19,688	212,548	230,198
Total	41,960,332	150,235,697	192,196,029	3,562,161	1.9	[4] 3,030	275,744	6,268,063	6,745,471

[1] The figures in these columns represent net increases at close of year. [2] Testing during 6 months.
[3] Represents decrease from figures for previous year. [4] Not including part of 1 county.

The work under the area plan was conducted on a large scale during the year. Approximately 83 percent of all the cattle tested were handled under this plan. The following States were added to the modified accredited area: Rhode Island, Vermont, Pennsylvania, and Maryland. The total number of States so declared on June 30, 1937, was 44.

At the same time the modified accredited area included 3,030 counties and part of 1 other county. This number included 28 modified accredited areas in Puerto Rico. Of all the counties in the United States 96 percent were in the modified accredited area at the end of the year, and more than 99 percent were either in the modified area or engaged in the area plan of testing. At the close of the fiscal year 29 counties in California, 2 in New Jersey, and 5 in New York were engaged in intensive testing.

TUBERCULOSIS IN POULTRY AND SWINE

The control and eradication of the avian (fowl) type of tuberculosis, which is readily transmissible to swine, have been a part of the regular program for the eradication of tuberculosis from livestock.

The survey of farm poultry flocks begun several years ago, in connection with the testing of cattle for tuberculosis, was continued, and during the year 128,351 flocks of poultry, containing 15,813,814 fowls, located in 12 States, were observed by the veterinarians in the field. As a result of such observations, infection was reported on about 3,000 farms. This feature of the work was conducted with little cost because the veterinarians who made the observations were engaged in the tuberculin testing of cattle.

The result of tests of cattle for Johne's disease, or para-tuberculosis, made with either johnin or avian tuberculin, showed that this disease existed to a slight degree in 11 States; 136 cattle, or 6.2 percent of the total number tested, were condemned on account of this disease.

As a separate additional project, about 15 Bureau veterinarians were assigned to the eradication of avian tuberculosis in the Midwestern and North

Central States, where the disease is most prevalent. These employees visited about 12,000 farms and observed about 1,615,000 fowls. They reported infection on about 3,000 farms. Much literature and other information on methods of eliminating disease from poultry and swine were furnished the owners, and they were also advised to attend meetings where avian tuberculosis was discussed.

TESTING CATTLE FOR INTERSTATE SHIPMENT

Approved veterinary practitioners throughout the 48 States continued to conduct testing of cattle for interstate shipment. On June 30, 1937, there were 10,957 veterinarians on the approved list. These men tested for interstate shipment about 16,500 lots of cattle containing about 187,000 cattle, of which 0.09 percent reacted. Testing done in connection with interstate shipment of cattle is included in the total testing reported in table 21.

BANG'S DISEASE

The work in connection with elimination of cattle reacting to the test for Bang's disease was continued during the year. The project was conducted with the cooperation of the livestock owners and the livestock sanitary authorities and continued to be on a voluntary basis as far as the Federal Government was concerned. The owners were required to sign an agreement requiring certain action on their part that was considered necessary in the proper handling of herds of cattle in the Bang's disease elimination project.

The maximum payment for grade cattle was $25 and for purebred registered cattle $50. The owner received the salvage in addition to Federal payment. In Maine, New Hampshire, Virginia, Delaware, and Rhode Island the owner received an additional payment from the State for the cattle that were eliminated. In no instance does the owner receive from all sources more than the appraised value.

Approximately $10,532,257 was used during the year for making payments to owners for eliminated cattle, and the operating expenses amounted to about $3,100,000. During the year, agglutination blood tests for Bang's disease were applied to 8,021,167 cattle. A considerable number of the tests were retests. Of this number of cattle tested, 397,864, or about 5 percent, were declared to be reactors to the test.

In several States there is a plan of operation whereby the owner may receive a certificate indicating that his herd has passed a sufficient number of tests to become certified as free from Bang's disease. The Federal Government does not participate in furnishing these certificates. In a few States plans have been made whereby the testing of cattle for Bang's disease can be conducted on an area basis. Usually the area consists of a county.

The average appraisal for cattle reacting to the test for Bang's disease during the year was $70.67, the average salvage was $27.94, and the average Federal payment of the year was $26.45. Of all the reactors, 9.0 percent were purebred registered cattle.

DIVISION OF VIRUS-SERUM CONTROL

The Division of Virus-Serum Control, directed by D. I. Skidmore, chief, continued to conduct regulatory and administrative work authorized by the Virus-Serum-Toxin Act. It also administered the marketing agreement for handlers of anti-hog-cholera serum and hog-cholera virus. This agreement was made effective December 7, 1936, by an order of the Secretary of Agriculture, dated December 2, 1936.

WORK AT LICENSED ESTABLISHMENTS

At the close of the year supervision was exercised over 76 licensed establishments as compared with 77 last year. These establishments were distributed among 54 cities and towns in 20 States. At the close of the year 36 establishments were engaged in producing only anti-hog-cholera serum and hog-cholera virus, 34 were producing other biologics only, and 6 were producing both classes of products.

Bureau inspectors examined 331,529 hogs and 660 calves intended for use in licensed establishments. Of these, 37 hogs were rejected at the time they were offered for admission, and 24,552 hogs were rejected because of conditions developing later which made them unsuitable for use. The total number of animal inspections was 2,263,757. Bureau inspectors supervised 3,410 potency

and 2,895 purity tests of anti-hog-cholera serum and 1,824 purity tests of simultaneous virus.

OUTPUT OF BIOLOGICAL PRODUCTS

Table 22 shows the quantities of biologics produced by licensed establishments under the Bureau's supervision.

TABLE 22.—*Biological products produced by licensed establishments, fiscal year 1937*

Product	Quantity
	Cubic centimeters
Anti-hog-cholera serum and hog-cholera virus:	
Serum	804, 141, 182
Virus (simultaneous)	51, 322, 067
Virus (hyperimmunizing)	152, 984, 470
Virus (inoculating)	622, 999
	Doses
Aggressins:	
Anthrax aggressin	9, 960
Blackleg aggressin (cultural)	1, 552, 520
Blackleg aggressin (natural)	3, 063, 370
Hemorrhagic-septicemia aggressin	1, 659, 368
Total	6, 285, 218
Antitoxins:	
Antivenin (venom serum)	199
	Units
Botulinus antitoxin	153, 392, 500
Tetanus antitoxin	526, 357, 000
Total	679, 749, 500
	Doses
Serums:	
Abortion serum (bovine)	1, 200
Anthrax serum	303, 091
Blackleg serum	3, 714
Bronchisepticus-bacillus serum (canine)	13, 647
Distemper serum (canine)	665, 503
Distemper and influenza serum (equine)	68, 483
Encephalomyelitis serum (equine)	46, 505
Enteritis serum (feline)	5, 890
Enteritis serum (porcine)	7, 610
Erysipelas serum (porcine)	414, 116
Gonadin serum	4, 289
Hemorrhagic-septicemia serum	182, 414
Mastitis serum (bovine)	2, 506
Mixed-infection serum (canine)	148, 336
Mixed-infection serum (feline)	11, 966
Mixed-infection serum (porcine)	8, 390
Navel-ill serum (equine)	22, 952
Normal serum (bovine)	1, 085
Normal serum (equine)	33, 713
Normal serum (porcine)	562
Scours serum (bovine)	67, 654
Total	2, 013, 626
Bacterins:	
Abortion bacterin (equine)	2, 627
Anthrax bacterin	103, 030
Autogenous bacterin	188, 662
Blackleg bacterin	7, 770, 110
Distemper bacterin (feline)	2, 695
Distemper, influenza, and pneumonia bacterin (equine)	756, 635
Enteritis bacterin (porcine)	348, 498
Hemolyticus-bacillus bacterin	94, 275
Hemorrhagic-septicemia bacterin	5, 450, 799
Keratitis bacterin (bovine)	869, 702
Mastitis bacterin (bovine)	496, 476
	Doses
Bacterins—Continued.	
Metritis bacterin (bovine)	33, 568
Mixed bacterin (avian)	19, 571, 551
Mixed bacterin (bovine)	2, 064, 708
Mixed bacterin (canine)	431, 158
Mixed bacterin (equine)	150, 735
Mixed bacterin (feline)	27, 706
Mixed bacterin (leporine)	6, 295
Mixed bacterin (ovine)	893, 264
Mixed bacterin (porcine)	1, 928, 054
Navel-ill bacterin (equine)	127, 591
Roup bacterin	446, 610
Scours bacterin (bovine)	361, 851
Staphylococcic bacterin (canine)	6, 917
Streptococcic bacterin (equine)	1, 554
Typhoid bacterin (avian)	97, 960
Total	42, 233, 031
Vaccines and viruses:	
Abortion vaccine (bovine)	273, 156
Anthrax vaccine	2, 484, 570
Blackleg vaccine	1, 298, 970
Distemper vaccine (canine)	154, 175
Distemper virus (canine)	63, 740
Ecthyma vaccine (ovine)	2, 329, 500
Encephalomyelitis vaccine (equine)	65, 148
Erysipelas vaccine (porcine) (export only)	235, 680
Laryngotracheitis vaccine (avian)	5, 765, 700
Pox vaccine (fowl)	19, 971, 850
Rabies vaccine	1, 038, 070
Total	33, 680, 559
Toxins and toxoids:	
Staphylococcus toxoid	7, 040
Tetanus toxoid	10, 710
Total	17, 750
Diagnostics:	
Mallein:	
Intradermic	6, 570
Ophthalmic	66, 550
Subcutaneous	1, 364
Total	74, 484
Pullorin	90, 950
Tuberculin:	
Intradermic	1, 502, 845
Ophthalmic	71, 089
Subcutaneous	31, 262
Total	1, 605, 196
Tuberculin (avian)	209, 421
Total	1, 980, 051
Grand total:	
Doses	86, 210, 434
Units	679, 749, 500

PRODUCTS REJECTED

Table 23 shows the quantities of biological products found to be unfit for marketing. Most of them were rejected in the course of preparation, whereas others were recalled from the market and destroyed.

TABLE 23.—*Biological products rejected and destroyed because of unfitness for marketing, fiscal year 1937*

Product	Quantity	Product	Quantity
	Cubic centimeters		*Doses*
Anti-hog-cholera serum:			
From animals found diseased	2,403,107	Abortion vaccine (bovine)	29,929
Contaminated and otherwise unfit	990,834	Hemorrhagic-septicemia aggressin	3,540
Hyperimmunizing virus (hog cholera):		Pox vaccine (fowl)	900
From animals found diseased	4,163,590	Tuberculin (intradermic)	141,410
Contaminated and otherwise unfit	329,179	Tuberculin (avian)	5,640
Simultaneous virus (hog cholera):			
From animals found diseased	724,670	Total	181,419
Contaminated and otherwise unfit	851,869		
Total	9,463,249		

IMPORTS AND EXPORTS OF BIOLOGICAL PRODUCTS

The importation of veterinary biological products from foreign countries continued to be handled by the Bureau in cooperation with the Treasury and Post Office Departments and the Food and Drug Administration of the Department of Agriculture. At the close of the year two permits to import such products were outstanding. Twenty-six shipments of biologics were offered for admittance to this country. Twenty-three of these, upon examination by Bureau inspectors, were found to be biologics which had been exported from the United States but were returned for various reasons. One shipment was refused entry because it was not covered by a permit; the remaining two shipments were admitted.

Bureau inspectors issued 447 certificates to accompany shipments of veterinary biological products to foreign countries. These certificates covered the following quantities of products: Anti-hog-cholera serum, 8,610,400 cc; hog-cholera virus, 711,765 cc; aggressins, 402,397 doses; bacterins, 558,416 doses; diagnostic agents, 52,304 doses; antitoxins, 3,618,548 units; serums and antiserums, 20,143 doses; vaccines, 590,997 doses. The total quantity of anti-hog-cholera serum reported to the Bureau as having been exported aggregated 13,276,450 cc. Additional exports of biological products, not covered by Bureau certificates and of unknown quantity, likewise were made to certain foreign countries which do not require certificates for such products.

SERUM-MARKETING AGREEMENT

An act of the Seventy-fourth Congress (48 Stat. 781–782) empowered the Secretary of Agriculture to consult with manufacturers of anti-hog-cholera serum and hog-cholera virus with respect to the commercial handling and distribution of such products that move in interstate or foreign commerce. A marketing agreement prepared under this authority and tentatively approved during the preceding fiscal year became effective December 7, 1936. The agreement, together with an order issued by the Secretary, was published as Bureau of Animal Industry Order 361, the chief purpose being to stabilize the volume and marketing conditions of these biological products. Under the agreement and order a control agency is established consisting of 12 members of the serum-virus industry, whose acts are subject to review by the Secretary, who has authority to disapprove them and to terminate the agreement should need arise for such action.

The agreement and order provide, in part, that each handler shall file with the Secretary and the control agency a separate list of his selling prices to each class of buyers, including terms of sale and discounts. All price lists also must be made immediately available to the daily and trade press and to the consuming public. These prices and terms do not become effective until 3 days after they are filed. During this time they cannot be withdrawn by the handler, neither can the handler file new prices and terms nor can he sell on any other basis during this 3-day period.

There are now 128 handlers classed as wholesalers and 2 as volume contract purchasers marketing anti-hog-cholera serum and hog-cholera virus. Of these handlers, 42 are producers of serum and virus under United States veterinary licenses.

ZOOLOGICAL DIVISION

Basic research on animal parasites, testing of control measures, and experiments with drugs and chemicals to discover practical methods of destroying the eggs and larvae of parasites in manure and of removing parasites from livestock and poultry were carried out under the direction of Benjamin Schwartz, chief.

PARASITES OF HORSES

In a continuation of studies on the effects of plowing on the eggs and larvae of horse strongyles, freshly passed horse feces containing strongyle eggs were buried in four different types of soil. In general, the greater the depth of burial the greater was the reduction of the migration of infective larvae to the surface of the soil. The type of soil used not only affected the migration of the larvae to the surface, but also appeared to influence the number of larvae persisting in the deeper layers. No infective larvae reached the surface of clay soil in about 4 to 5½ months after the burial of the feces to depths of about 3½ to 10½ inches. An insignificant number of larvae reached the surface of sandy clay loam during the same period after burial of the feces to the depths mentioned. Larvae from about 9 percent of the eggs reached the surface when the feces were buried in fine sandy loam and in coarse sand for from 3 to 5½ months. A comparatively large proportion of the eggs buried in sandy clay loam and a small proportion of those buried in coarse sand were represented by infective larvae in the locations in which the feces were buried. These last-mentioned observations were made 3½ to 6 months after the burial of the feces to depths of 3½ and 8½ inches, respectively. These investigations show that deep plowing of clay and sandy clay loam soils probably constitutes an effective method of freeing land from infective larvae of horse strongyles. Despite the fact that many larvae survived in the deeper layers of sandy clay loam, comparatively few of them reached the surface. Although comparatively few larvae survived in coarse sand, a relatively large number of these reached the surface, apparently because of the absence of obstruction to their migration.

In an attempt to determine the constituents of horse urine that are deleterious to the eggs of various horse strongyles, such eggs were placed in solutions of urea, uric acid, creatinine, and neutralized hippuric acid. The eggs hatched in all the solutions mentioned. Hatching was not observed in nonneutralized solutions of hippuric acid. This finding suggests that an unfavorable hydrogen-ion concentration was responsible for the failure of the eggs to develop in this solution. However, it was found that eggs failed to hatch in neutralized horse urine, indicating that the presence of some lethal factor in urine, distinct from an unfavorable hydrogen-ion concentration, is responsible for destroying the viability of the eggs.

Experiments on the effects of low temperatures on the development of the eggs and preinfective larvae of horse strongyles yielded the following results: Temperatures just above freezing stopped the development of the eggs and the preinfected larvae but failed to destroy the viability of the eggs in 33 days and to kill the larvae in 12 days. Temperatures ranging from —3° to —10° C. stopped the development of eggs and larvae, killed most of the preinfective larvae in 12 days, but failed to destroy the viability of the eggs in 33 days. Infective larvae are known to be highly resistant to subfreezing temperatures.

Carbon tetrachloride, ethylene dichloride, a mixture of these two compounds, and a preparation of dichloropentanes were separately tested to determine their efficacy in destroying the viability of eggs and killing preinfective larvae of horse strongyles in manure which was exposed in a closed container to these volatile substances for 23 to 90 hours. The viability of practically all the eggs so exposed was destroyed, as determined by subsequent cultures of the exposed feces. The preparations used were obviously deleterious to the infective larvae, but their efficacy in this respect was not nearly so great as in the case of the eggs and preinfective larvae.

In cooperation with the Pathological Division, experiments are in progress to determine the role of strongyles, particularly *Strongylus* spp., in the transmission of swamp fever (p. 43).

PARASITES OF RUMINANTS

PROTOZOA

The brown dog tick (*Rhipicephalus sanguineus*) failed to transmit anaplasmosis when the larvae were engorged on a recovered carrier and the nymphs which developed from these larvae were engorged on a susceptible bovine host. The brown dog tick and the Rocky Mountain spotted fever tick (*Dermacentor andersoni*) failed to transmit anaplasmosis when the adults engorged on a recovered bovine carrier and seed ticks and nymphs of the next generation engorged on rabbits were finally placed as adults on susceptible bovines.

The causative organism of anaplasmosis was killed in the red blood cells of cattle by alternate freezing and thawing for two or three successive times. The laked blood cells that had been thawed and frozen as stated, were injected intravenously into susceptible bovines to determine whether this material would act as a protective vaccine. The results indicated that the injection of this material appeared to increase the resistance of the bovines to subsequent injections of virulent blood, this resistance manifesting itself by an increased incubation period of the disease.

Experiments with *Trichomonas foetus*, a flagellated protozoan that has been incriminated as an agent of sterility and abortion in cattle, were carried out as follows: Into the vaginae of 4 virgin heifers, negative to the agglutination test for Bang's disease, there were inoculated bacteria-free cultures of the flagellated protozoan. All these heifers became infected, the period of incubation varying from 24 to 48 hours. One heifer retained the infection for 21 days, another for 44 days, a third for 83 days, and the fourth for 87 days, so far as could be determined by direct examination of vaginal smears and by cultures of material obtained from the vaginae of these animals. In general, the infection with the organism resulted in a disturbance of the oestrus cycle, and none of the animals became pregnant so long as organisms could be demonstrated in the genital tract. Although these heifers appeared to be pregnant at the end of the year, it was not known whether they were actually pregnant or whether their uteri were filled with a fluid containing the protozoan organisms. Two control heifers from the same lot became pregnant after a single service, each giving birth to a normal calf.

An examination of the dairy herd at the National Agricultural Research Center, showed 11 animals to be infected with *Trichomonas foetus*. Of these animals, five were cows that had dropped from one to three normal calves before acquiring the infection. Of the six remaining animals, four were 2 years old and failed to become pregnant despite repeated services by bulls; one animal, 3 years old, aborted at the end of the sixth month of pregnancy; and one, a virgin heifer, was found to be infected, indicating that the disease in not strictly venereal.

A survey of a small flock of sheep maintained by the Zoological Division at Beltsville showed the presence of seven species of coccidia belonging to the genus *Eimeria*. Five of these species have been previously described and two appear to be new. Of the previously described species, two were encountered frequently and in large numbers, the remaining three species occurring only sporadically. One of the new species was found in great numbers, often in association with a mild diarrhea; the other new species is apparently rare.

An experimental study of the infection in young lambs showed that these animals acquired significant infections 5 days after being placed on infested pastures. The infected animals developed diarrhea, this symptom corresponding to the period of heavy infection. One lamb to which four different kinds of coccidia were administered developed a heavy infection which reached a peak from the eleventh to the eighteenth day after infection. During this period the lamb showed symptoms of weakness, dullness, and labored respiration, and suffered from a bloody diarrhea. Recovery was rapid, the disappearance of the symptoms corresponding to the decline of the infection.

TREMATODES

Studies of the conditions influencing the development and hatching of the eggs of the common liver fluke showed that when eggs of this parasite were incubated in water at temperatures of 33° to 38° C., no development took place and the contents of the eggs soon underwent disintegration. This finding indicates that under natural conditions liver-fluke eggs would probably not embryonate in warm, shallow, stagnant pools. Eggs in water hermetically sealed in glass tubes and provided with a small air space remained undeveloped for 37

days at room temperature but developed normally when the seal was broken. When eggs were concentrated to a thickness of 3 mm in vials having a water depth of 37 mm, and left undisturbed, development took place slowly at room temperature, and hatching continued over a period of 112 days. These two experiments indicate that abundant oxygen is necessary for the normal development and hatching of liver-fluke eggs. They also indicate that under field conditions eggs mixed with feces and mud in water may not develop normally and that hatching may be intermittent, making possible more or less continuous infection of the intermediate snail host over a considerable period.

Liver fluke-control measures were continued in the Rocky Mountain and Pacific Coast States with the aid of emergency funds. Large-scale demonstrations of control measures, principally by drainage of wet, swampy, and boggy lands used for pasturing cattle and sheep, were carried out in California, Idaho, Montana, Oregon, Utah, and Washington.

CESTODES

In May 1937 tapeworm-free lambs were put on a pasture known to have been infested with eggs of tapeworms (*Moniezia* spp.) early in the spring of 1935. From that time until the lambs were placed on the pasture comparatively few *Moniezia* eggs had been deposited on it. The lambs became infested with tapeworms during the first 30 days. This result is in harmony with the findings of other workers that a pasture infested with eggs of tapeworms affecting ruminants retains the infective material over two winters.

NEMATODES

Investigations of the ecological relationships of the eggs and larvae of the stomach worm (*Haemonchus contortus*) of ruminants yielded the following results: The viability of the eggs was destroyed rather rapidly at temperatures below freezing. The optimum temperature for the development of the eggs was found to be between 70° and 80° F. When feces containing stomach-worm eggs became dry because of prevailing weather conditions, the number of eggs that developed into larvae was materially reduced. During July 1936, the hot, dry weather reduced considerably the development of the eggs of this parasite. Under natural conditions the larvae died rather rapidly at first. Of those that survived many were long-lived, and observations, as yet incomplete, showed that the survival period extended to 9 months.

To obtain information on the effects of the stomach worm on the growth of sheep, several lambs, entirely free from worm parasites, were infected experimentally with stomach worm larvae. On an average, the infected lambs required approximately 205 pounds more feed per 100 pounds of gain in live weight than did the uninfested controls. The failure to make proper growth was found to be closely correlated with the number of parasites recovered from the infested lambs post mortem. The infested lambs developed a severe anemia associated with considerable loss of blood through hemorrhage in the wall of the stomach. There was no modification of the digestibility coefficients of the various constituents in the rations fed to the infested lambs, except an apparent decrease in the digestibility of the nonprotein nitrogenous material. Whether this was due to hemorrhage, incomplete digestion of protein, or to other causes has not yet been determined. The infested lambs developed a resistance to superinfections with stomach worms, this resistance being shown by the presence of many immature worms long after the period required for the development of the parasites to sexual maturity.

Studies of the development of an intestinal threadworm (*Cooperia curticei*) of sheep showed that the larval worms became localized in nodules in the mucosa of the small intestine of lambs when the host animals were subjected to repeated infection. The localization of the larvae in nodules is apparently the expression of a resistance on the part of the host to repeated infections.

ARTHROPODS

In a continuation of investigations begun in 1934 at Colorado Springs, Colo., and at Galesburg, Ill., on the possible effect, on milk production, of infestation with ox warbles, the following work was done: One lot of 12 selected dairy cows was kept in a fly-tight screened pen from December 1 to July 1 for 2 successive years; another lot of 12 cows, of approximately the same age and the same milk-production record, was kept for the same period in an enclosure which was not screened. During the first year the cows in the screened pen

had an average of 17.7 warbles per animal and produced an average of 39.4 pounds of milk a day. Those in the unscreened pen had an average of 19.7 warbles per cow and an average daily milk production of 31 pounds. During the second year the cows in the screened pen were free from warbles and produced a daily average of 24.4 pounds of milk per cow. During the same period the cows in the unscreened pen had an average of 17.9 warbles per cow and the daily milk production average 33.3 pounds per cow. Since all the factors that may have been involved have not been ascertained, no definite conclusions can be drawn from this experiment.

Attempts to control ox warbles in cattle by applying to the hair coat various preparations have yielded unsatisfactory results. Paraffin dissolved in gasoline was sprayed lightly on the hair of cattle during the season of activity of the adult fly. The preparation caused some loss of hair and failed to prevent the hatching of the eggs. Work with various rotenone preparations is still in progress. The testing of various insecticides and medicated rods on infested cattle was continued, but none of the preparations was found to be suitable for rapid application, safety, and high effectiveness. Work with vacuum machines and nozzles resulted in important improvements in the construction of the nozzle, which greatly increased the effectiveness of mechanical removal of warbles. A hand-operated suction apparatus was designed and given a limited series of trials.

Work on grub in the head of sheep was continued at Las Vegas, N. Mex., and at San Angelo, Tex. Results of controlled tests showed that a 3-percent solution of lysol killed the larvae when the medicament was brought into actual contact with these parasites in the nasal passages and head cavities of sheep. Approximately 6,650 range sheep were treated with a 3-percent lysol solution in November 1936; about 2 ounces of the solution was used for each sheep. Results, as yet incomplete, indicate that one treatment reduced infestation in range flocks by about 80 percent. Experiments with nose guards to prevent the adult fly from depositing larvae in the nostrils of sheep were continued. A large number of sticky mixtures, containing camphor, zinc sulphate, sulphur, coal-tar creosote, pine tar, bone oil, and other substances, were applied around the nostrils of sheep to trap or kill the young larvae. These applications did not prevent infestation.

PARASITES OF SWINE

TRICHINAE

Experimental infections of pigs with trichinae showed that low-grade infections produced a slight increase in the eosinophiles; heavy infections produced a significant rise in the eosinophiles. Although the pigs showed fever during the acute stage of the infection, no symptoms having a differential diagnostic value were observed in any of the six animals that were under observation. The pigs that had heavy infections, with an average of 840 to 1,215 trichinae per gram of muscle tissue, made uneventful recoveries and were in good condition at the time they were killed.

In view of the fact that occasional reports come to the Bureau which indicate that human trichinosis might have been acquired as a result of eating raw or undercooked beef, three steers were infected experimentally with trichinae. These host animals developed fever and showed a loss of appetite and a loss of weight. The invasion of the muscle by trichinae was manifested by a stiff gait. An examination of 450 samples of beef-muscle tissue taken from the pillars of the diaphragm yielded negative results.

Tests were conducted in cooperation with the Bureau of Home Economics, to determine whether the temperature found to be effective in destroying the vitality of trichinae under the conditions in meat-packing establishments supervised by Government inspectors, would be equally effective when fresh pork is heated under conditions approximating those of the home. In these tests, fresh hams, fresh shoulders, and fresh pork loins were heated in ovens and in water only until the internal temperature in the thicker part of the meat reached 137° F., rather than carrying them to the temperature usually recommended for home cooking, which is about 185°. The results obtained indicated that when an internal temperature of 137° was reached the vitality of all trichinae present was completely destroyed. As a result of these studies, it is believed that the usually recommended home methods of cooking pork have an ample margin of safety to insure the destruction of the vitality of the trichinae.

In a continuation of studies on the incidence of trichinae in garbage-fed and nongarbage-fed hogs, determined by the digestion of approximately ½-pound samples of pork taken from the pillars of the diaphragm, the following results

were obtained: Of 3,876 samples of pork, obtained mostly in two Pacific Coast States, from hogs that had been fed raw garbage, 3.4 percent were infested. Of 1,860 samples from the same general area, obtained from hogs fed cooked garbage, 0.59 percent were infested. Of 1,535 samples from hogs originating in the Middle West and not fed garbage, so far as known, 0.32 percent were infested. These results show that the frequency of trichinae in hogs fed raw garbage was approximately six times as great as that in hogs fed cooked garbage and that the frequency of trichinae in hogs fed cooked garbage was approximately twice that of hogs not fed garbage. These data show that the control of trichinae in hogs involves for the most part the avoidance of feeding raw garbage. A total of 1,894 samples of pork food products, prepared to be eaten customarily without cooking, were examined for trichinae by the digestion method; these samples originated in establishments operating under Federal inspection. Only five samples contained trichinae, these being dead. These results, based on random sampling, indicate that the Federal requirements with regard to processing are effective in destroying the vitality of trichinae.

STOMACH WORMS

Investigations on the red stomach worm (*Hyostrongylus rubidus*), a parasite causing ulceration of the stomach wall of swine, showed that the eggs appeared in the feces 21 to 24 days after the administration of infective larvae. Eggs were still present in the feces of the infested swine 5 months later, indicating that the infestation persisted for a relatively long period. Ecological studies showed that the infective larvae were most frequently encountered in moist soil beneath litter and droppings of infested hogs and on moist shady soil where feces had been trampled. A few larvae were occasionally found in moist soil beneath a layer of dry soil several inches thick, indicating that the larvae migrated downward and remained where conditions were optimum for their survival. Under field conditions, larvae were not found in exceedingly wet or dry soil, but under experimental conditions the larvae were found to survive as long as 23 days in shaded, artificial mud holes and from 10 to 14 days in unshaded artificial mud holes.

Daily administration, for 2 weeks before infection and continuing for 3 weeks after infection, of a dilute solution of a mixture of copper sulphate and iron sulphate resulted in reducing to a significant degree the number of worms in experimentally infected pigs as compared with those found in controls fed the same infecting dose of larvae.

In the general run of hogs that were slaughtered in one meat-packing establishment in the South, it was determined that about 37 percent of the pigs were infested with the red stomach worm. Of 209 pigs raised in accordance with the sanitation plan, approximately 15 percent were found to be infested. In another group of 172 pigs not raised in accordance with all the recommendations of the sanitation plan, approximately 40 percent were infested.

CONTROL OF SWINE PARASITES

In the general run of hogs in the South, kidney worms and other parasites continue to exact a heavy toll from swine producers as shown by the following facts: Records from four meat-packing establishments under Federal inspection showed that of 95,478 hogs originating in southern Georgia, Alabama, and northern Florida, only 5.5 percent of the livers and 1.25 percent of the kidneys were saved for food. In one plant, 239 carcasses were condemned entirely for extensive kidney-worm infestation during 1 month. In contrast to this high percentage of infestation, the benefits obtained by those who followed the swine-sanitation program were as follows:

Of 821 hogs from 85 projects in southern Georgia and northern Florida, 513 were raised in accordance with all the essential requirements of the swine sanitation set-up as developed by this Bureau. The remaining hogs were raised in accordance with some of the essential requirements, but a number of the important preventive measures were not followed. Hogs raised strictly in accordance with the sanitation system were examined post mortem with the following results: Eighty-seven percent of the livers were passed for food, and 93 percent of the kidneys and kidney fat were free from parasites. In the hogs not raised strictly in accordance with the sanitation plan, only 41 percent of the livers were saved for food and only 70 percent of the kidneys and associated fat were free from worms. These findings indicate that a strict adherence to the sanitation system is essential to obtain the best results. A premium was paid by a southern packing company to those who raised their

hogs in accordance with the sanitation system, the total amount paid in extra checks being $434.11.

POULTRY PARASITES

ROUNDWORMS

Experimental studies on the poultry gapeworm showed that infested turkeys began to cough and wheeze beginning on the seventh day after experimental infection and that these symptoms continued for several weeks. The appearance of the symptoms corresponded very closely with the period of migration of the worms from the lungs to the trachea. The tracheas of infested turkeys became highly inflamed and contained large nodules which resulted from the attachment of the worms to their walls. Lesions in the lungs were observed as early as a few days and as late as 3 to 4 weeks after experimental infection, the injuries consisting of necrotic areas which sometimes involved nearly one-half the affected lungs.

Turkeys of all ages were found to be susceptible to infection with gapeworms, birds 4 to 5 months old being exceedingly susceptible and often dying as a result of heavy infestation. Evidence showed that turkeys lost the infestation rather rapidly and that such birds were probably refractory to subsequent infestation. Pigeons appeared to be highly refractory to infestation with gapeworms, and guinea fowls were apparently highly susceptible. The latter are probably carriers of gapeworms.

An examination of 936 turkey tracheas showed that approximately 15 percent were infested with gapeworms, the number of worms in individual birds varying from 2 to 46. This percentage is considerably lower than that in 1921, when the last observations were recorded.

Studies on the intestinal capillarid (*Capillaria columbae*) of pigeons showed that the bird host becomes infested as a result of swallowing the infective eggs. These hatch in the intestinal tract and the larvae invade the lining of the small intestine. Following the completion of the molts, the worms become sexually mature, the whole cycle of development requiring approximately 4 weeks. Pigeons were found to be very susceptible to infestation with this parasite. Young pigeons, in particular, suffered from the ravages of the worms. Among the symptoms observed were emaciation, diarrhea, listlessness, and little or no desire on the part of the birds to eat and drink. Heavy infestations produced death. Chickens were found to be highly susceptible to these worms and acquired fatal infestations when placed in pens occupied by heavily infested pigeons.

Life-history studies on the crop worm (*Capillaria annulata*) of chickens and turkeys were completed. The earthworm intermediate host was found to acquire the larval stages of the parasite as a result of swallowing the embryonated eggs with soil. The eggs hatched in the intestinal tract of the earthworm, and the larvae migrated to the body musculature, where they molted before attaining the infective stage. The entire cycle of the development in the earthworm required at least 23 days. Infested earthworms fed to chickens before the required 23-day period following experimental infection did not produce an infestation in chickens.

TAPEWORMS

A detailed study was made on the life cycle of a poultry tapeworm (*Choanotaenia infundibulum*) which is transmitted by dung beetles and grasshoppers. Two common species of flour beetles were found to serve as intermediate hosts of three species of poultry tapeworms, namely, *Hymenolepis carioca*, *C. infundibulum*, and *Raillietina cesticillus*. Since these beetles have a cosmopolitan distribution, they are probably important hosts of the tapeworms named. Flour beetles are available at all seasons of the year, and the discovery that these insects are suitable intermediate hosts affords an opportunity of carrying out experimental studies with the tapeworms named, more particularly, studies to determine the possible relation of these parasites to fowl paralysis and other infectious diseases of poultry.

MISCELLANEOUS PARASITES

TREMATODES

Taxonomical and morphological studies of trematodes were continued. Several papers based on these studies, including descriptions of 11 new species and 4 new genera, were published. *Clinostomum attenuatum*, a fluke normally occur-

ring in the American bittern, was reported for the first time as a parasite of the chicken. Life-history investigations of trematodes were continued, and the second intermediate host of *Euryhelmis squamula*, a parasite of minks and occasionally of cats, was found to be a common frog, *Rana pipiens*.

CESTODES

An investigation was undertaken to determine the life history of the anoplocephaline tapeworms, a group containing representatives in domestic animals and in many wild animals and birds. Preliminary investigations have been carried out with the common rabbit tapeworm (*Cittotaenia* sp.) as a source of material. Studies of the eggs of this parasite showed that the embryos in the eggs are very resistant to low temperatures. Eggs in water were able to survive intermittent freezing and thawing for more than 3 months. When kept at 3° to 4° C. the eggs were found to retain their vitality for more than a year. Under ordinary room temperature the eggs lost their vitality in less than 2 months.

Attempts to infect various possible intermediate hosts, including small crustaceans, insects, and annelids, have so far been unsuccessful. Small crustaceans (*Cyclops*) were found to ingest the eggs. The freed larvae remained alive for several hours in the intestinal tract of *Cyclops*. Attempts to infect rabbits by feeding eggs exposed to various environmental conditions, feces containing eggs, and dirt and grass from experimentally contaminated plots, gave negative results.

A number of domestic rabbits known to be free from tapeworm infestation were placed on areas frequented by wild rabbits. All remained negative except one animal, which became infested with two tapeworms.

An ecological study of wild rabbits in the vicinity in which the experiments were carried out showed that wild rabbits were heavily infested with *Cittotaenia* during the fall and winter months, and that the infestations were lost or egg production ceased by early spring. This investigation also showed that rabbits abandon their winter feeding grounds early in the spring, indicating that in the case of these host animals, these areas are probably of little importance as sources of infection.

NEMATODES

Studies on the histological anatomy of nematodes to determine characters on which to base a sound natural classification were continued and the results are included in a paper in course of publication. A study of the esophagus of the whipworm showed that this organ is functional and that the worm obtains its nourishment by direct withdrawal of blood from its host. About 20 new species and 4 new genera of nematodes were described during the year.

A chemico-physical study of the sphaerocrystalloids of several economically important nematodes showed that these structures are composed chiefly of calcium sulphate, in *Ascaris*, *Strongylus*, and *Trichuris*. So far as known, these bodies occur only in blood-sucking nematodes, and their relative abundance seems to be a possible index to the blood-sucking activity of these worms.

Investigations on the vector problem of the dog heart worm were continued. Seven young dogs were placed in a flea-proof enclosure containing a dog heavily infested with fleas and also infested with heart worms, and were kept under these conditions for periods varying from 68 to 142 days. The dogs thus exposed were killed at various intervals and all were found to be negative for heartworm infection. The results of this experiment indicate that fleas play no role in the transmission of the dog heart worm.

Repeated examinations of blood from a dog transfused with blood from a dog heavily infested with heart worms showed that viable larvae were still present in the circulation 27 months later, indicating that dogs may serve as reservoirs of infection for a long time after the reproductive activity of the adult worms had ceased.

In cooperation with the Office of Experiment Stations, a study of the effects of such factors as rain and sunlight under tropical conditions on the development and survival of eggs and larvae of economically important nematodes parasitic in domestic animals was carried out in Puerto Rico, with the following results:

Unembryonated eggs of the swine ascarid failed to survive the effects of direct sunlight for more than 3 hours when in water or for more than 2 hours when dried. Embryonated eggs of this parasite were somewhat more resistant as they survived for 5½ to 9 hours in water and about 5 hours when dried. Infective larvae of the swine kidney worm, the swine nodular worm, the sheep stomach worm, and the dog hookworm were killed in 1 hour when exposed in

water to direct sunlight, whereas those of horse strongyles under similar conditions were still alive after 9 hours. Infective larvae of the species mentioned, with the exception of horse strongyle larvae, failed to survive for more than 20 days on unshaded, gently sloping grassy areas, or for more than 12 days on partly shaded bare soil. They failed to survive for more than 6 days on bare soil on a steep slope. On unshaded level areas covered by grass 12 inches or more in height, these larvae survived for more than 2 months, or throughout the duration of the experiment. Viable larvae of horse strongyles under these conditions were quite resistant and could be recovered at any time during the experiment until dispersed by heavy rains. Viable eggs of the swine ascarid and the swine thorn-headed worm were not recovered after 25 days on unshaded, gently sloping grassy areas or after 16 days on partly shaded bare soil, but were recovered throughout the duration of the experiment (more than 2 months) on unshaded level areas covered with grass 12 inches or more in height and on constantly shaded areas on a gentle slope.

These experiments indicate that the combined factors of sunlight, heat, and air drying in the Tropics during the dry season are probably effective in destroying most parasite eggs and larvae on pastures, provided the growth of grass is not so dense as to protect such eggs and larvae from these inimical factors.

MISCELLANEOUS IDENTIFICATIONS

Routine identifications of parasites were made during the year for various governmental agencies, educational institutions, and individuals. These identifications comprised about 320 nematodes and acanthocephalids, 104 cestdodes, 52 trematodes, 1,597 ticks, and 70 miscellaneous arthropods, pentastomes, and

TREATMENT FOR THE REMOVAL OF PARASITES

Further experiments with brilliant green for the removal of tapeworms from chickens showed that the effective dose is too toxic to be used. Experiments with N-butyl chloride in doses of 1 cc per kilogram of body weight for the removal of whipworms from dogs showed that 61 percent of all the whipworms harbored by 21 host animals were removed by one treatment. Ten of the twenty-one treated dogs passed all their whipworms after one treatment. Before treatment, these animals were infested with hookworms and ascarids as well as whipworms, and the anthelmintic proved to be 100-percent effective against all the parasites harbored. Treatment with butyl chloride removed between 99 and 100 percent of all cylicostomes and between 70 and 100 percent of all *Strongylus* spp. from two horses. One horse lightly infested with *Oxyuris* passed all these worms after the treatment mentioned, and another horse heavily infested with a small nematode (*Probstmayria vivipara*) passed many of these worms after the treatment.

Preliminary results indicate that tobacco dust fed in the mash and p-tertiary amyl phenol given in formalized gelatin capsules can be used successfully in treating pigeons for the removal of large intestinal roundworms.

Thirteen different compounds were tested in the treatment of canine filariasis, but none of the preparations used was found to be efficacious in killing the microfilariae in the blood and the adult worms in the heart. On the basis of available evidence fuadin stands as the accepted remedy for the destruction of heart worms in dogs.

Chrysanthin, a plant product related to santonin, was tested as an anthelmintic on dogs with negative results. Spigelia, an old worm remedy said to have been used by American Indians and still used in some proprietary remedies, was tested and found to possess anthelmintic properties, though it was found to be somewhat toxic. When this drug was dried for a time it became nontoxic and also noneffective.

INDEX CATALOG AND COLLECTION OF PARASITES

The index catalog was maintained in its various sections, including the author, subject, and host catalogs, and the sections of specific and subspecific names. The B section of the author catalog was sent to the printer and approximately one-half of the C section has been prepared. Of the 2,901 specimens added to the helminthological collections, 1,094 were entered under the Bureau of Animal Industry collection and 1,807 in the collection of the United States National Museum.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - - Price 10 cents

REPORT OF THE CHIEF OF THE BUREAU OF BIOLOGICAL SURVEY

•

1937

REPORT OF THE CHIEF OF THE BUREAU OF BIOLOGICAL SURVEY, 1937

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF BIOLOGICAL SURVEY,
Washington, D. C., September 15, 1937.

Hon. HENRY A. WALLACE,
Secretary of Agriculture.

DEAR MR. SECRETARY: I present herewith the report of the Bureau of Biological Survey for the fiscal year ended June 30, 1937.

Sincerely yours,

IRA N. GABRIELSON, *Chief.*

CONTENTS

INTRODUCTION

THE CHIEF PROGRAM OF THE YEAR

With the formulation of the national wildlife program that inspired conservationists in 1935 and 1936, a program with objectives that approached the ideal more closely than had been found practicable in any that preceded it, the Bureau of Biological Survey has settled down to the more matter-of-fact but equally essential task of carrying out the details. It is this sort of activity that has characterized the work of the year—this and the continuing development of attitudes and plans to provide greater and broader cooperation for the restoration and conservation of the Nation's wildlife resources.

As waterfowl management is fundamentally dependent upon the availability of breeding stocks, it is incumbent upon the individual sportsman, organizations interested in wildlife, and the local, the State, and the Federal Governments, each in its peculiar field, to carry out its own obligations in effecting the return of birds to the nesting grounds. It is now gratifying to report that with the educational and informational work that has been undertaken over many years, including that of the Biological Survey, this responsibility is being taken more and more seriously: there is increasing cooperation between Federal and State Governments, and there is ever more manifest among sportsmen a willingness to support and abide by regulations restricting former liberal hunting privileges. There is also a growing appreciation of the fact that unless hunters exercise self-restraint in the kill of migratory game, there will be no birds to occupy the refuges now being acquired and improved under a $21,000,000 program and the plans for the restoration and rehabilitation of this great resource will be fruitless.

The conservation gains thus attained since the inception of the waterfowl-restoration program are now being consolidated. The farsightedness that resulted in the provision of funds for beginning the execution of the Survey's waterfowl recommendations over many years brought forth numerous diverse and widely scattered proposals for refuge restoration. The original plans are being carefully scrutinized, and through careful research the chief efforts are now devoted to a distribution of refuges that will benefit all sections of the country and all species of wildlife.

Less spectacular than the engineering works for the restoration of water areas, than the flights of increasing numbers of wild fowl to the reestablished lakes and marshes on their ancestral breeding grounds, is the underlying research. This research, as instituted by the Bureau more than half a century ago is being expanded to cover the new conditions brought about by the inception of the restoration program. Although the chief emphasis has been on the successful prosecution of this program, there has been no relaxation in other directions. Research has been vigorously pursued affecting nonmigratory game and nongame species, their distribution and abundance in the wild, their economic status, and their susceptibility to propagation and perpetuation under controlled conditions, as on fur farms, game preserves, and elsewhere.

Many who live in favored sections, in which waterfowl will always be found so long as any remain on the continent, still ask the Bureau for more liberal hunting privileges, either from purely selfish motives or through an incomplete understanding of the calamitous conditions in other parts, particularly on far-distant breeding grounds that produce under highly adverse conditions the very birds they wish to shoot. To illustrate, except for small numbers of a few species, the middle Atlantic seaboard does not produce the waterfowl locally hunted. Rather, many species come from the great prairie sloughs of the North Central States and Canada, so that improvement of local breeding grounds only cannot increase the supply of the birds sufficiently to meet the hunters' requirements. In such areas the only possible local help is to limit the kill while the rehabilitation of breeding grounds is going on and serious efforts are being made to restock the restored refuges.

Hunting regulations are irksome, as are most restraints on individual initiative, and it is no pleasant task for the Biological Survey to impose restrictions on the use of a national resource that was traditionally available to all citizens from the time of the discovery and early settlement of the country up to a generation ago. When the dwindling of this resource began to be felt, it was then almost too late to remedy the situation. Even conservation officials shared the rather general opinion that there was no hope for the waterfowl and that, as they seemed destined to go anyway, the season might just as well be opened wide to allow duck hunting 12 months in the year—on the nesting grounds, on the spring migration routes, and anywhere else.

If the old hopeless condition still prevailed many would feel exactly the same way about it now, but it has undergone a change. During the last 3 years, since the Biological Survey has for the first time been enabled to do constructive work on a scale large enough to give real hope for the future, more than $20,000,000 has been available for the purchase and development of refuges, including restoration of water levels, providing better feeding, breeding, and wintering grounds, and fencing and posting areas acquired. The program is simple and biologically sound but by no means completed. Its success depends upon many factors, some of which are outside the control of those handling the work.

In the first place, if there are to continue to be ducks and geese in this country, they must have suitable habitat in which to breed, feed, and rest—in other words, marshy areas in localities favorable for the birds must be increased rather than further drained. In the second place, adequate breeding stock must be returned to these marshes and to the far greater nesting areas of Canada.

The knowledge that waterfowl follow four main flyways in traveling twice a year between breeding and wintering grounds has influenced the selection of sites for refuges. Surveys show that there are in this country approximately 7,500,000 acres of marshland well situated along these flyways that can be restored to constitute the framework of an adequate refuge system. To supplement these major areas, the Bureau is endeavoring to restore by local cooperation every available acre of marsh within the natural breeding grounds of the birds.

The habitat-restoration work is usually in places not readily accessible to great numbers of people, and thus much of it is not seen, which is just as well, because successful nesting demands seclusion. The waterfowl breeding grounds within our continental territory are largely in the northern tier of States west of the Great Lakes, a region that experienced a great calamity when changed by the drainage movement that swept the country in the last century. Both Federal and State Governments wish to put water back in many of the drained ponds and marshes. Up to the present time the Biological Survey has acquired or optioned, or has had reserved by Executive order, more than 2,000,000 acres on which restoration measures and improvements for wild fowl are now being undertaken. Examples of nesting-ground restoration are given in later pages of this report. When present funds are exhausted the program will have reached nearly the halfway mark. The completion of the work depends to a large extent upon the support the program receives from the sportsmen of the country. The constructive work of refuge rehabilitation is interesting and fascinating. Restrictive measures applied to such outdoor recreation as waterfowl hunting, though never popular, are necessary.

There is no magic way to restock the new and former breeding areas. Either an increasing number of birds must be allowed to return to them each spring or the sport of duck hunting will vanish. The necessity for severe restrictions on hunting has not passed.

As intimated in the report a year ago, for the first time in 10 years or more, a slightly increased breeding stock returned northward in 1936. That meant that the drastic restrictions of 1935 reduced the losses among the birds to less than the number that were produced the previous spring. It is encouraging to report that continuation of the restrictions during the 1936 season and the cooperation of sportsmen had a similar result: the number of birds returning to the breeding grounds in 1937 exceeded the number of 1936. These facts were ascertained on the breeding grounds by Survey representatives who have checked certain definite areas during many seasons.

OUTSTANDING EVENTS

Events that marked the past year's work of the Biological Survey may be briefly noted as follows, the details being given on subsequent pages:

WILDLIFE RESEARCH

Research centers.—Assignment of the first permanent research worker to the Wichita Mountains Wildlife Refuge (Okla.) and near completion of a wildlife laboratory there; and establishment and planning the development of the Patuxent Research Refuge (Md.).

Reestablishing musk oxen.—Safe transfer of the remaining 27 animals in the musk ox herd to Nunivak Island from the Experiment Station at Fairbanks, Alaska.

January waterfowl inventory.—Confirmation of earlier conclusions that ducks and geese are slowly increasing in numbers, by cooperative surveys of waterfowl-concentration areas of the United States by an army of fully 2,000 biologists, game-management agents, pilots of water and air craft, and other personnel.

Investigations in Mexico.—Reports by two field parties that despite limited market shooting, migratory waterfowl probably enjoy greater security during their sojourn in eastern and western Mexico than elsewhere on the continent.

Mosquito-control studies.—Injury to wildlife checked by persistent surveillance of Federal, State, and municipal drainage and mosquito-control projects.

Predation on waterfowl.—Completion of waterfowl-nesting studies in two contrasting areas, from which it is indicated that the emphasis on predation changes from year to year, crows being locally responsible for nestling mortality at one time and skunks, weasels, foxes, or other predators at others.

Food of coyote.—Completion of a 6-year stomach-analysis study of the food of the coyote in relation to livestock and wildlife, as a basis for formulating control policies.

Rabbit experiments.—Determination by cooperative experimental hat manufacture of the relative felting qualities of wild cottontail and jack rabbit pelts; and demonstration of the value of the self-feeder, whereby whole grains are utilized and feed costs lessened, almost revolutionizing domestic rabbit-feeding practices.

Sex in fox-pelt values.—Through study of receipts from auction sales of some 10,000 silver fox skins, demonstration that pelts of males, both pups and adults, brought higher prices than those of females.

Quail diseases.—More prompt diagnosis and eradication of epizootics on game farms made possible by study of protozoan infections in bobwhite quail.

Deer and tick fever.—Demonstration that deer in Florida are hosts of the tropical variety of the fever tick.

NATIONAL WILDLIFE REFUGES

Refuge lands purchased.—Approval or consummation of negotiations for the acquisition of 134,655 acres of waterfowl refuge lands at an average cost of $10.46 an acre, bringing the total of national wildlife refuge lands purchased since July 1, 1933, to 1,558,298 acres, at an average cost of $6.50 an acre.

Refuges reserved by the President.—Establishment by Executive orders of 11 national wildlife refuges, aggregating 1,874,300 acres in 7 States, primarily for the protection and preservation of resident game species, bringing the total thus reserved in 4 years to 4,037,470 acres in 17 refuges.

Refuge surveys.—Surveying, monumenting, posting, and mapping 295,900 acres in 57 national wildlife refuges, as prerequisites to adequate administration.

Acquisition expenditures.—Expenditure of $1,123,051 in acquiring new refuges for migratory birds, purchasing areas previously optioned, and completing purchases of lands within the boundaries of older refuges.

Extension of easement-refuge program.—Extension into Montana of the easement-refuge program of migratory-waterfowl restoration, begun in North Dakota last year, bringing the number of projects completed or under construction to 75 and the acreage to 118,777.

W. P. A. cooperation.—Allotments totaling $1,628,926 made by the Works Progress Administration for developing refuges in 10 States.

N. Y. A. assistance.—Through cooperation on the part of the National Youth Administration, the employment of several hundred young men in making waterfowl observations, food and cover plantings, and nesting studies on migratory-bird refuges.

Refuge development by C. C. C.—Refuge development by Civilian Conservation Corps enrollees extended to 28 waterfowl refuges and big-game preserves, primarily in building up essential water resources and food and cover growth.

Refuge utilization.—An estimated threefold to fivefold increase since the inception of the emergency program in 1934 of the wildlife populations on the Bureau's migratory-bird refuges.

LEGISLATION AND REGULATION

Mexican treaty.—Exchange of ratifications and proclamation on March 15, 1937, of a Convention between the United States and the United Mexican States for protecting migratory birds and regulating shipments of game mammals between the two countries.

Hunting regulations.—Providing protection by close seasons for brant on Atlantic coast and for redhead and canvasback ducks.

Law enforcement.—Successful prosecution for conspiracy to violate the Lacey Act of persons illegally handling furs, and continuance of the drive against duck bootleggers and persons taking waterfowl by means of bait.

PREDATOR AND RODENT CONTROL

Predators in Alaska.—Resumption of predatory-animal control in Alaska to demonstrate methods to resident trappers and to aid them in obtaining necessary equipment.

Control of rodents.—Under Bureau supervision reduction of rodents on 34,652,418 acres for the protection of farm crops, range grasses, silvicultural plantings, and reclamation waterways and the conservation of surface soils; and development of improved orchard-mouse baits and field practices in New England.

Hawaiian rat control.—Establishment of a control-methods laboratory and bait-production plant in Honolulu for experiments in rat control and for the manufacture and canning of baits for distribution to island plantations.

KEEPING THE PUBLIC INFORMED

To present currently the results of its research and other activities, the Biological Survey contributes to the several series of publications of the Department and issues, chiefly for use in replying to correspondence, a mimeographed series of Wildlife Research and Management Leaflets, references to certain numbers of which are made under appropriate headings in this report. The Bureau on occasion has issued statements for the press, through which interested groups are currently informed on its activities, and has participated through its public-relations and other technical staff in radio programs. To promote visual information on its work for wildlife, the Survey has participated in exhibits, cooperated in motion-picture production, and contributed film strips to the Department's series with accompanying outlines for lectures. Through members of its technical staff the Bureau has been represented during the year at numerous gatherings of ornithologists, mammalogists, conservationists, sportsmen, wildlife managers, fur farmers, stockmen, and others interested in the protection, propagation, utilization, and control of the Nation's valuable resources in wild-animal life and has thus had opportunity to present in greater detail and to special groups such information as is summarized in this report. Two of its published contributions, combining the programs and subject matter of several projects, may here be noted: Wildlife in Land Planning (Leaflet BS–71) and Game Management on the Farm (Farmers Bulletin No. 1759). Of the latter 90,000 copies were printed, two-thirds of which were distributed before the end of the fiscal year.

FUNDS AVAILABLE TO THE SURVEY

From regular and emergency appropriations a total of approximately $6,030,000 was available for the work of the Survey for the year. Of this sum $1,836,224 was carried in the Agricultural Appropriation Act for regular activities; an estimated total of $600,000 has been collected from sales of Federal migratory-bird hunting stamps; and $12,340 was allocated to the Bureau from the Bankhead-Jones special research fund for an economic study of wildlife management as a supplementary farm enterprise. The sum of $40,000 was allotted from the Emergency Relief Appropriation Act of 1935 to complete work carried on in North Dakota on the development of waterfowl refuges, and $6,100 for resulting administrative expenses. A total of $1,588,926 was assigned from the Emergency Relief Appropriation Act of 1936 to conserve water and wildlife, to check floods and erosion, to increase fur production, to provide stable water supplies, and to create Federal waterfowl refuges in North Dakota, South Dakota, Montana, Nebraska, Louisiana, Oklahoma, Wisconsin, Wyoming, and Michigan and $47,500 for administrative expenses. For expenditures in connection with work performed by the C. C. C. on national wildlife refuges, a total of approximately $1,900,000 was made available to the Bureau.

ORGANIZATION OF THE BUREAU

To bring about more efficient administration, including coordination of activities and expedition of work, and to engender a group spirit and solidarity, plans for a reorganization of the Survey's field services were completed to become effective July 15, 1937. With the exception of research functions, regulation of importations of foreign wildlife forms, and land-acquisition work, all field activities will be placed under a regional organization. The 10 regional directors are subject to instructions directly from the Chief of Bureau and the

heads of divisions and sections in Washington. The present organization, with officials in charge, is as follows:

Chief of Bureau—Ira N. Gabrielson
Associate Chief—W. C. Henderson
Technical adviser and research specialist—W. L. McAtee
Division of Administration—W. R. Dillon
Assistant—Thos. E. Jacoby
Section of Personnel and Pay Rolls—E. J. Thompson
Section of Accounting—S. C. Moore
Section of Purchases and Property—J. L. Talbert
Section of Mails and Files—W. D. Hobbs
Division of Public Relations—H. P. Sheldon
Assistant, in charge of Editorial Section—Wm. H. Cheesman
Section of Current and Visual Information—Howard Zahniser
Division of Wildlife Research—W. B. Bell
Section of Wildlife Surveys—H. H. T. Jackson
Section of Distribution and Migration of Birds—F. C. Lincoln
Section of Food Habits—Clarence Cottam
Section of Fur Resources—Frank G. Ashbrook
Section of Disease Control—J. E. Shillinger
Division of Land Acquisition—Rudolph Diffenbach
Section of Appraisals and Negotiations—R. M. Rutherford
Section of Surveys and Maps—A. A. Riemer
Division of Migratory Waterfowl—J. C. Salyer, II
Assistant, in charge of Section of Maintenance and Patrol—A. C. Elmer
Section of Reconnaissance and Habitat Improvement—W. F. Kubichek
Section of Restoration and Development—Amos B. Emery
Division of Game Management—Stanley P. Young
Assistant, in charge of Section of Big Game Refuges and Game Agents—W. E. Crouch
Section of Law Enforcement—F. P. Callaghan
Section of Importations and Permits—R. W. Williams
Section of Predator and Rodent Control—A. M. Day
Regional directors (with headquarters):
Region 1 (Pacific), Portland, Oreg—Wm. M. Rush
Region 2 (Mountain), Denver, Colo—Leo L. Laythe
Region 3 (Southwestern), Albuquerque, N. Mex—Donald A. Gilchrist
Region 4 (West Central), Des Moines, Iowa—George Tonkin
Region 5 (Southern), State College, Miss—Roy Moore
Region 6 (East Central), Milwaukee, Wis—Daniel H. Janzen
Region 7 (Southeastern), Atlanta, Ga—James Silver
Region 8 (Northeastern), Portland, Maine—Bertrand E. Smith
Region 9 (Plains), Omaha, Nebr—Burnie Maurek (acting)
Region 10 (Alaska), Juneau, Alaska—Frank Dufresne

VETERAN WORKERS RETIRED

Three veteran workers of the Bureau were retired during the year: Theo. H. Scheffer was retired on February 28 after 27 years in scientific and control work in Washington, D. C., and in the field, during which he was the author of Farmers' Bulletins and other publications on moles, pocket gophers, mountain beavers, and the crested myna. Harry H. French, after 32 years' service in the Department, which began in the Forest Service in 1905, was retired on January 31 as superintendent of the Wichita Mountains (Okla.) Wildlife Refuge, with which he had been connected since 1926, during the earlier years as Forest Service supervisor. Ethel N. Jett, who began work in 1908, also with the Forest Service, was retired on January 31 after 17 years' service with the Survey, during the last part of which she was custodian of the Bureau's photograph files.

RESEARCH ON WILDLIFE STATUS AND MANAGEMENT

STATUS OF WATERFOWL

SURVEYS IN CANADA

At the beginning of the year four field parties of biologists were making waterfowl observations on the southern Canadian breeding grounds, one in British Columbia, the second in Alberta and western Saskatchewan, the third in eastern Saskatchewan and Manitoba, and the fourth in Nova Scotia and New Brunswick, and a fifth party worked north through the Mackenzie River Valley to its vast Arctic-coast delta. All observers were guarded in voicing optimism on the results of their work, but the leaders were in agreement in supporting the opinion of the previous year that the decline of most species had been stopped.

Breeding-ground observations were resumed during the spring of 1937, and at the close of June all four of the Bureau's flyway biologists, including two recently appointed for the Atlantic and Central flyways, and one party made

up of two experienced game-management agents, were still in the field, in most cases on the identical areas surveyed in past years. The northeastern party made a short reconnaissance of Newfoundland, which included, through cooperation of Newfoundland officials, an aerial survey without expense to this Bureau. All parties report almost weekly by mail or telegraph, but final reports will not be at hand until early fall.

INVESTIGATIONS IN MEXICO

Two field parties of biologists were sent in December to investigate waterfowl conditions south of the Rio Grande, one on the lakes, marshes, and lagoons of the western parts of Mexico, the other in the east. A third party was given a short assignment in the Valley of Mexico. The western operations were extended south to Acapulco, and the eastern to the Laguna de Tamiahua, south of Tampico. Most of the larger lakes and lagoons known to be important wintering areas were visited and their waterfowl populations carefully checked. The eastern party, while in the Laguna Madre section of Texas, saw a raft of redheads, conservatively estimated at about 100,000 birds, or more than the combined reports on the species from all other areas.

Despite the notion entertained by many sportsmen that waterfowl are slaughtered in large numbers in Mexico by the use of armadas and other wholesale destructive devices, the birds appear to be safer in that country than in any other part of the North American Continent. Some marketing of wild fowl was found, but the number of birds so taken throughout all of Mexico is far less than the slaughter by sportsmen in any one of our important waterfowl States. The use of armadas (batteries of guns) has now been prohibited by the Mexican Government. Some Mexican areas used by waterfowl have suffered from drainage, but in general, conditions for the winter sojourn of the birds in that country are highly favorable.

JANUARY INVENTORY IN THE UNITED STATES

As the culmination of the year's investigations on the status of waterfowl, a January inventory was planned and executed under the direction of the Bureau's regional officers, so as greatly to increase the coverage. The disastrous Ohio-Mississippi flood violently disrupted plans for region 5 (southern), but throughout the season the regional director and his agents had maintained such close touch with the waterfowl situation that the status of the birds was known with a fair degree of accuracy before they were dispersed over thousands of square miles of flooded bottom land.

A large part of the field personnel of the Bureau was assigned to this work, and these forces were augmented by State police and conservation officers, members of the Forest Service, Soil Conservation Service, Bureau of Agricultural Engineering, C. C. C. camps, State agricultural colleges and universities, and others. Patrol boats and other watercraft were supplied by the States, by the Bureau of Marine Inspection and Navigation, and by the Coast Guard. Aircraft were furnished by the Army Air Corps, the Naval Air Service, the Coast Guard, a commercial tire and rubber company, and a few private individuals. In region 7 (southeastern), the regional director had 18 seaplanes and blimps and 1 autogiro at his disposal. Three naval blimps from Lakehurst, N. J., were used in region 8 (northeastern), while in region 5 one naval bomber made a flight of 1,700 miles across the Gulf from Pensacola, Fla., to the mouth of the Sabine River, Tex. In some of the snowbound interior districts the observers carried out their assignments with a fine spirit of cooperation by the use of snowshoes.

MIGRATION OBSERVATIONS BY COOPERATORS

Reports on the status of waterfowl within the United States were received from 655 cooperating observers for the fall migration of 1936, and from 594 of these volunteers for the spring of 1937. Their tabulations and analyses fully substantiated the reports of the official staff upon studies in 1936 on the breeding grounds.

SUMMARY OF REPORTS

The reports are in substantial agreement that the mallard, black duck, pintail, baldpate, Canada goose, and blue goose are the species now in the most satisfactory condition, and that the menaced goldeneye is steadily increasing.

The status of the other diving ducks continues unsatisfactory, and although the canvasback made notable gains it is still necessary to give complete protection to the redhead, the canvasback, and the ruddy duck. The findings from the investigations on the status of waterfowl are basic considerations in the adoption of regulations placing restrictions on hunting. They were given in some detail in a mimeographed leaflet (BS–88) issued in May.

RESEARCH ON FOREST AND RANGE FAUNA

Progress was made during the year in cooperation with the Forest Service in research on the relationships of wildlife to forestry, grazing, and other land use.

At the Harrison Experimental Forest, in Mississippi, particular attention has been devoted to birds in relation to the destruction of longleaf pine seed. Observations and check experiments show that during a year of low seed production birds are not attracted to the area affected and that they are not apt to destroy planted seed. Research also has been conducted on the distribution and relative abundance of rodents, on comparison of late fall and early spring plantings in relation to destruction of pine seed by birds and mammals, and on the distribution and population of birds and mammals in the Gulf States.

Research temporarily suspended at the Lake States Forest Experiment Station was renewed in September, and studies were resumed on the relation of rodents and rabbits to forest plantings. Investigations of the status and food habits of white-tailed deer, and their effect on the forests, and studies of management of winter feeding yards of deer have shown that it is not always so much general lack of cover or food that makes winter conditions critical for deer as it is the inadequate distribution of these necessities. Forested winter concentration areas need more openings provided with browse, and the open burns, logged lands, and brush areas are in need of cover to attract deer from the food-depleted "yards." Some advance also has been made at the Lake States station in a long-time study of the beaver, particularly as to its food and water requirements, and in developing methods for determining the carrying capacity of the environment for these mammals.

At the California Forest Experiment Station a study of the relationship of wildlife to the regeneration of pine forests is a major project. On cut-over areas in the sugar pine–fir type, sugar pine is not restocking as desired, reproduction being largely to white fir and incense cedar. Rodents, by their response to habitat changes following cutting and by their food preferences, play an important part in the regeneration of certain species of trees. Damage by rabbits to seedlings planted during the fall of 1934 at Big Springs brushlands was approximately 40 percent to Jeffrey pine and 60 percent to ponderosa pine. Studies have been made at this station of the effect of burns on animal life and forest renewal. Research has continued on wildlife in relation to the range and to forage production, and on animal-plant interrelationships. In these studies experimental enclosures and check exclosures have been set up for ground squirrels, pocket gophers, and kangaroo rats, and the former stocked to determine the quantity and kinds of forage consumed by each rodent. The biologist at this station is also cooperating with the Forest Service in studies of quail management and coyote-deer relationships.

The research suspended for nearly a year on the Pillsbury State Forest, in New Hampshire, was resumed in April, with special emphasis, as formerly, on the ruffed grouse. Wildlife-management studies included observations on response to cover manipulation, on the movements and seasonal requirements of game, and on cultural methods for use in cover management. Practical measures employed included the encouragement or planting of satisfactory food plants after experimental work to determine the requirements of the plants and of the wildlife species for which intended.

In an investigation of transplanted beavers, conducted in Oregon in cooperation with the Forest Service, special attention was paid to the food requirements of these animals and to the suitability of the colonization sites.

Under a cooperative agreement with the Forest Service, evaluations of national forests as wildlife areas have been made in Minnesota, Wisconsin, Michigan, New Hampshire, Vermont, Virginia, West Virginia, Kentucky, North Carolina, Tennessee, Georgia, Florida, Mississippi, Louisiana, Arkansas, Missouri, and Oklahoma. Among recommendations made were the following; That before roads or trails are built, or recreational areas established, the regional and forest wildlife technicians be consulted; that forest-road develop-

ment be analyzed and that where it is determined that roads are largely for administrative use they be closed to the public; that general stream surveys be made with the idea of selecting beaver-planting sites; that special attention be given to the livestock-grazing problem, to determine forest areas where recreational and wildlife uses might be of greater value than grazing, and that where the two are in conflict, control should be by regulation and strict patrol; that wildlife data be assembled and laid before the State game departments, and a mutual plan of action be agreed upon; that parts of forest nurseries be devoted to raising seedlings of wildlife food plants; that technicians be consulted and careful consideration and study be made, and an agreement reached, as to areas that should be reserved for game; that all forest uses be correlated closely with fish and game uses; and, that insect and rodent control be undertaken only where technical supervision can be furnished from the Bureau of Entomology and Plant Quarantine and the Bureau of Biological Survey, respectively.

BIOLOGICAL RESEARCH ON REFUGE AREAS

WICHITA MOUNTAINS WILDLIFE REFUGE

Work has been continued on an extensive research program for the Wichita Mountains Wildlife Refuge, in Oklahoma, and, although the laboratory building has not yet been completed, a biologist stationed there began work on January 1 on several problems. Plants have been collected for identification as a basis for cover-type studies, a cover-type map made of a 75-acre enclosure in the northwest corner of the refuge, and a cover-type study of Winter Valley pasture completed, the area mapped, and a survey made for fencing three experimental pastures.

PATUXENT RESEARCH REFUGE

The Patuxent Research Refuge area in Maryland was first occupied by the Bureau on May 15, 1936, by permission of the Resettlement Administration, 7 months before the refuge was established by Executive order, December 16, 1936. Its development has proceeded as expeditiously as possible with a small personnel, and preliminary surveys have been made of the existing plant and animal life. Thirteen miles of 9-foot nonclimbable fence have been erected in a boundary strip cleared 20 feet wide to facilitate its maintenance; 4 miles of service roads have been graded and graveled and 12 miles of trails cleared for patrol work; and 45 buildings and other structures that constituted a fire hazard have been razed and the usable material salvaged. A 60-acre tract is being cleared for a dam and pond to provide suitable habitat for waterfowl and other forms of aquatic life. A battery of 24 small ponds for experimental waterfowl-food studies is almost completed, and a well has been dug for a water supply. Pens for 32 minks and 24 foxes have been erected, and foxes for experimental work are now maintained on the refuge.

BEAR RIVER MIGRATORY BIRD REFUGE

Census methods for migrating, concentrating, and nesting waterfowl have been studied at the Bear River Migratory Bird Refuge, Utah, weekly censuses of the birds taken, concentrations mapped and recorded, and, through cooperation of the War Department, estimates of bird rafts in the Bear River delta made at intervals from airplanes. An investigation of the mammals of the refuge was begun during the year, and studies were made on the sex ratios of ducks and muskrats.

WILDLIFE-MANAGEMENT RESEARCH

COOPERATIVE RESEARCH UNITS

Nine units organized to undertake research in wildlife management have been established in cooperation with land-grant colleges and State game departments, funds for each of which are provided by the college, the State game department, the Bureau of Biological Survey, and the American Wildlife Institute. Research, education, and demonstration have gone forward, and the friendly cooperation, the attitude of the participants, and general recognition of the importance of the work have been most encouraging. Some of the accomplishments are here outlined, the information in more detail being available in a mimeographed leaflet (BS-87), covering the project from its inception to the end of January 1937.

The major problem handled by cooperators at the Alabama Polytechnic Institute, at Auburn, has been a study of the life history and management of the mourning dove. During the year nesting activities and food habits have received especial attention. Quail habits and management also have been studied, and advance has been made on an ecological study of the white-tailed deer.

In Connecticut a game-management demonstration area of 4,500 acres has been under management by cooperators from the State College at Storrs. An extensive study of the New England cottontail is under way, special attention having been paid to breeding and food habits and to home and seasonal range. Analytical study has developed a standard technique for appraisal of statistics of the game kill and for short-cut methods that will give necessary information for decisions as to hunting regulations 4 months prior to the season.

At the Iowa State College, at Ames, a study of the ecology and management of the blue-winged teal has been completed for publication. Progress has been made on an investigation of Mearns's cottontail rabbit, especially as to food and cover requirements, and on other researches into the life history, ecology, and management of the muskrat and of the American coot.

An investigation of forest-game relations has made progress from headquarters at the University of Maine, at Orono, in determining the effects of logging and pulpwood cutting on the welfare and distribution of game. Field work was begun in July also on a study of certain habits of the woodcock and of management manipulations necessary for its increase, a map showing distribution and relative abundance of the species in Maine was completed, detailed study was made of its "singing grounds" and nesting, and 73 individuals were banded.

A number of wildlife-management demonstration areas of township size have been set up in northwestern Ohio by the cooperative unit at the State University, at Columbus, where the effectiveness of various production and harvest techniques is being tested. Attention is being given also to the adjustment of farmer-sportsman relationships, a subject treated in some detail in a mimeographed leaflet (BS-93) issued by the Survey in April. Effort is being made to develop a waterfowl-management program for Pymatuning Lake on the Ohio-Pennsylvania boundary. A wildlife, recreational, and land-use study of 52,000 acres of State-owned forest lands in the unglaciated hills of southern Ohio includes the establishment of demonstration areas for controlled hunting, forest plots managed for forest wildlife, 12 special managed refuges and sanctuaries, a nursery, and extensive wildlife plantings. Life-history and management studies have been initiated on the gray squirrel, fox squirrel, white-tailed deer, and ruffed grouse.

Year-round investigations of small game in Willamette Valley, Oreg., were conducted by the unit at the State College, at Corvallis, in which it was learned that food, cover, and range were ample, but that there was a high mortality of immature birds because of unfavorable climatic conditions. A study of sex and fawn ratios of deer was conducted, and considerable progress made in research on the life history and management of the antelope. A 3,000-acre tract comprising several farms in the Willamette Valley was utilized as a game-management demonstration area.

A survey of the wildlife resources of Walker County, Tex., undertaken by the unit at the Texas Agricultural and Mechanical College, at College Station, has included an extensive quail census, a collection of birds, mammals, reptiles, and amphibians, and a study of their habits and of the wildlife utility of the principal vegetative types. Quail in Walker County were estimated at 40,255, and the average covey size on December 1, on grazed and hunted areas, was 11.25 birds, and on ungrazed areas protected from hunting, 16.8 birds. Findings indicate the possibility of more than doubling the quail population of the county through improvement of the habitat (particularly by control of grazing) and better regulation of hunting. A study of the gray squirrels and fox squirrels of eastern Texas has made headway.

The Texas unit has been active, through research, education, and extension, in efforts to conserve Attwater's prairie chicken, a subspecies now limited to a comparatively small area on the coastal prairie of the State. An estimate of its population last fall on 100,000 acres of 3 of the best counties gave 380 birds, or 1 to 263 acres. During the legal hunting season of 4 days, 45 of these (12 percent of the total population) were taken. Latest counts indicate a total of 625 of these prairie chickens in Colorado, Austin, and Wharton Counties. Through shortage of cover as a result of overgrazing or burning, the prairie chickens tend to nest in damp depressions bordering ponds, where they can find

concealing vegetation, but this exposes them to abnormally heavy losses from floods. Ninety percent of the young birds are estimated to have been lost during the 2 years 1935 and 1936. Fortunately a 5-year closed season was placed on this bird at this year's session of the Texas Legislature. The lesser prairie chicken of the Texas Panhandle is also in danger of extinction.

Through questionnaires, interviews, and field observations, a beginning has been made on an inventory of vanishing wildlife in Texas. Principally involved are certain species of big game and other large mammals, fur animals, hawks, and game birds. Some of these are reduced almost to the verge of extinction, and with few exceptions the trend for nearly all species, particularly game, is downward. Outstanding exceptions are the white-tailed deer and the wild turkey of the Edwards Plateau and southern Texas.

Investigation of the Rocky Mountain mule deer, the primary study of the unit at the Utah State Agricultural College, at Logan, has involved a wide variety of life-history features, distributional and forage requirements, and management problems. Particular attention has been given to sex ratios, winter losses, forage requirements, and migrations, and to the yield of deer on a given area and the various factors that enter into harvesting the crop.

A life-history and management study of the sage grouse, largest of native American grouse, was continued in Utah, with year-long observations on activities, migration, breeding, and feeding habits, and conditions affecting abundance. A series of 63 nests was studied through the incubation and hatching periods in an investigation of factors influencing hatching and the rearing of young. A definite correlation was found between type of cover and success of nesting. Sixty-five stomachs were collected for food analysis, mostly from birds struck by traffic on a highway.

The Utah Fish and Game Department cooperated in a State-wide beaver survey and in an intensive study of an 8-mile section of the Strawberry River, which contained 102 beaver dams and 991 acres of willows for forage. During October and November the pelts of 108 beavers, believed to be about half of the population of this area, yielded $1,022, or about $1.03 an acre.

The major research effort of the unit at the Virginia Polytechnic Institute, at Blacksburg, was the investigation of the life history, conservation, and management of the wild turkey. A method of producing the birds for restocking purposes was developed. Poults reared in a modified type of the Coleman movable quail pen were found to be wild to a remarkable degree when released, and later were not unduly decimated by shooting. Both deer- and grouse-management studies have been undertaken, and progress has been made in research on the food habits of foxes. Some 2,000 plant specimens have been collected for beginning a study of the distribution and ecology of native plants of the State that are utilized by wildlife. A check list of the birds of Virginia has been compiled, and good progress made on a study of the mammals.

WILDLIFE MANAGEMENT A SUPPLEMENTARY FARM ENTERPRISE

An investigation in cooperation with the Bureau of Agricultural Economics, begun in May 1936, of wildlife management as a supplementary occupation on farms, was continued throughout the year 1937. In a reconnaissance survey conferences were held in each State with the agricultural experiment station directors, their staffs, Federal and State land-use specialists, foresters, and others invited by the director to be present, and also wherever possible with members of the conservation departments and of State planning boards.

The outstanding results have been the stimulating of attention and interest and the bringing together of individuals and organizations that have some interest in the production, administration, and utilization of wildlife, particularly as related to agriculture and land use. The study thus far indicates that wildlife, to be perpetuated, must be produced by natural reproduction on farm lands as well as on lands publicly owned. State or Federal lands alone cannot supply sufficient wildlife or adequate facilities for its use and enjoyment by the public. Artificial propagation and restocking have proved to be unduly expensive as a direct means of providing hunting; and uncontrolled public shooting, especially on private farm land, has proved destructive both to wildlife and to farm property. Due respect for property rights is fundamental to success in encouraging private landowners to produce wildlife. The monetary consideration, particularly on lands of high value that are intensively used for agriculture, is of minor importance and under present conditions is not offering an adequate incentive for wildlife production on farms.

Inspection of wildlife-management work on Resettlement Administration projects in Maine, Maryland, and Rhode Island and reports and recommendations on management measures were made at the request of Resettlement regional directors. To summarize briefly the technology of wildlife management the Survey issued a leaflet (BS–67) on the subject in October, and later it was included in essence in a report of the National Resources Committee (pp. 135–136), on Technological Trends and National Policy.

BIOLOGICAL INVESTIGATIONS IN ALASKA

BUFFALO AND MUSK OX HERDS

Information procured as to the status of the buffalo brought 7 years ago from Montana to a point near McCarty, Alaska, shows a sixfold increase in the herd and the animals in good condition. The musk ox herd introduced into Alaska in 1930 was carefully tended and studied at the Bureau's experiment station at Fairbanks until last July, when the 27 animals remaining were transferred to Nunivak Island to join 4 others similarly transferred in a preliminary experiment in 1935. With care and protection this nucleus should thrive on Nunivak Island, and recent reports indicate that the herd probably will increase sufficiently to provide stock for reestablishing the musk ox as an important member of the mammalian fauna of Alaska.

WILDLIFE SURVEYS OF ISLANDS

The biological survey of wildlife conditions on the Aleutian Islands begun last year has been continued to the point where its early completion is foreseen. A field party of three biologists assigned to the work embarked this year from Seattle, on May 4, in the Bureau's patrol boat *Brown Bear*. Exploration began at the westernmost islands and continued eastward toward the mainland. As a result of the survey considerable data have thus far been obtained on the bird life of the Aleutian Islands, several new nesting records have been established, and information has been acquired on the breeding birds, their relative abundance, and the effects upon their numbers of foxes introduced on the islands.

BANDING GAME AND OTHER BIRDS

COOPERATORS

Physical limitations on maintaining the great mass of detailed bird-banding records with a high degree of accuracy dictate adherence to the policy of restricting the number of bird-banding stations. Despite the fact that offers of cooperation have been declined on the average of about 1 a day, there has been a slight increase in the number of banding cooperators, and at the close of the year the names of 2,129 were carried on the rolls. Of these 66 maintain active waterfowl stations, 21 on Federal refuges. Banding work also is becoming increasingly important in the national parks, with 16 active stations, chiefly in Western States.

A review of the activity of individual cooperators discloses that during the year 11 of them banded more than 5,000 birds each. The work of one of these aides set a new record for banding a single species, chimney swifts, his total for the year being 22,135. The operator next in line banded 20,128 birds, largely common terns. The third reported a total of 17,458 birds, chiefly waterfowl, a line of banding work that is especially valuable to the Bureau. Cooperators at 49 other stations reported the banding of more than 1,000 birds each during the year.

NEW BIRDS BANDED

The grand total of new bandings reported is for 300,207 birds of 391 species, an increase of more than 25,000 over the number for the previous year, including the following 9 species not heretofore banded: Paroquet auklet, parasitic jaeger, bridled tern, white-bellied booby, great white heron, Hudsonian curlew, Worthen's sparrow, Swainson's warbler, and hermit warbler. The number of bands purchased and issued was 415,000. Birds banded in greatest numbers were the chimney swift (29,112), common tern (25,354), herring gull (16,304), mallard (15,753), white-throated sparrow (15,716), and pintail (11,767). Records of banding by species are made known to cooperators in various issues of Bird Banding Notes (mimeographed).

That the banding of migratory waterfowl continues to receive close attention is shown by data in table 1. With the establishment of stations on national wildlife refuges that have resident managers, this phase of the work can be made more selective, since actual operations will be under immediate supervision. In view of this development, and to simplify administration, few additional waterfowl-banding stations of the volunteer class are being authorized.

TABLE 1.—*Waterfowl banded in the fiscal years 1936 and 1937*

Species	1936	1937	Species	1936	1937
American merganser	12	7	Lesser scaup	906	[7] 969
Red-breasted merganser	2	10	Ring-necked duck	1,357	951
Hooded merganser	10	7	Goldeneye	2	3
Mallard	14,526	[1] 15,753	Bufflehead	55	43
Black duck	4,283	[2] 4,892	Harlequin duck	6	
Florida duck		44	American eider	1	
Gadwall	173	1,238	Pacific eider		2
Baldpate	657	1,426	White-winged scoter	1	
Green-winged teal	2,642	4,803	Ruddy duck	16	36
Blue-winged teal	2,475	4,740	Snow goose		9
Cinnamon teal	215	183	Blue goose	68	96
Shoveler	100	349	White-fronted goose	4	1
Pintail	11,894	[3] 11,767	Canada goose	436	386
Wood duck	597	[4] 888	Whistling swan	3	
Redhead	521	[5] 927			
Canvasback	553	[6] 226	Total	41,742	49,822
Greater scaup	227	66			

[1] Including 1,434 hand-reared mallards.
[2] Including 1,279 hand-reared black ducks.
[3] Including 519 hand-reared pintails.
[4] Including 430 hand-reared wood ducks.
[5] Including 110 hand-reared redheads.
[6] Including 41 hand-reared canvasbacks.
[7] Including 50 hand-reared lesser scaups.

RETURNS AND RECOVERIES

During the year 17,011 records were reported of the recovery of banded birds, either at the station of banding or elsewhere. This is 1,257 less than for the previous year, but may be accounted for by the shorter shooting season of 1936, which materially reduced the waterfowl kill by sportsmen. The cards carrying banding data are punched and automatically distributed in the files, but because of a considerable accumulation, amounting to about 35,000 cards, the Survey was assisted in the tabulating-machine work by the Bureau of Agricultural Economics.

RECORDS OF BIRD DISTRIBUTION

Data in the card index of the distribution and migration of birds were increased during the year by 39,000 entries, bringing the total number of cards in this file to well over 2,000,000. Migration observers regularly reporting now total 383. Additions to the list are made only when the prospective cooperator is favorably located and is qualified to contribute worth-while information. Further, now that the files are so large, special care is exercised to see that only usable references from the literature are added.

Work on bird-distribution maps is now well under way, and those for the group of gulls and terns, nearly completed, will be followed as soon as practicable by those for the cuckoos, woodpeckers, goatsuckers, hummingbirds, and swifts. These groups will figure in the next bulletin of the United States National Museum on the life histories of North American birds, for which the parts on distribution and migration will be prepared in the Biological Survey, as for the bulletin issued during the year on the life histories of the birds of prey. A series of maps showing original and present breeding ranges has been completed for certain important migratory and upland game birds, as well as for the larger game and fur mammals. When complete it should provide significant information for the use of legislative committees and for conservationists and other students of wildlife conditions.

Circular No. 428 of the Department, issued in May, entitled "Flight Speed of Birds", summarizes and tabulates information not only for game birds but for many other species also and presents an extensive bibliography on the subject.

STATE SURVEYS AND REPORTS

Studies of the mammals of Florida, which have been carried on intermittently since 1918, were considerably advanced as a result of 2 months' field work in the peninsula. Investigations have been continued also on the life zones and mammals of Arizona, where several man-months have been spent in intensive field study. An extensive monograph describing the life zones of Oregon and the relationships, habits, and distribution of the mammals of the State was published in August as North American Fauna No. 55.

Substantial progress was made on a revision of the manuscript on the bird life of Texas, in connection with which a taxonomic revision of the western screech owls was necessary, and resulted in the preparation for publication of descriptions of three new subspecies; similar byproducts of the Texas work were descriptions of a new jay and a new towhee, and further revisions, wholly or partly completed, of the long-billed marsh wrens, song sparrows, Maryland yellowthroats, hermit thrushes, and cowbirds.

A leaflet (BS–76) entitled "Some Suggestions for Bird Field Study" was issued in December to aid individuals and bird-study clubs in deriving permanent benefits from what to some has been merely a passing hobby.

REFERENCE COLLECTIONS AND RECORDS

The research collections and records of mammals, birds, and other vertebrates continue to be a necessary foundation for the work of the Bureau. Consistent advance has been made in assembling and recording information based on the collections and on reports regarding the habits, life histories, relationships, and distribution of species. During the year 855 mammal specimens were added to the Biological Survey collection at the United States National Museum, and 712 were identified for 38 institutions and individuals in 22 States and 2 foreign countries. Specimens to the number of 557 were borrowed for study from 11 institutions in 7 States, and 581 were lent to 18 institutions in 7 States and 2 foreign countries.

The facilities of the mammal laboratories were used by 33 research workers from 12 States and 2 foreign countries. Biologists of the Bureau also have used the collection in describing 16 new mammals of the genera *Canis*, *Felis*, *Peromyscus*, *Dipodomys*, *Tamiasciurus*, *Glaucomys*, *Antrozous*, and *Ovis*, and a biologist from the University of California described a new *Mustela* in the collection. Mammal type specimens in the Biological Survey collection now number 949, and a catalog of them for publication in the North American Fauna series is nearing completion.

Bird specimens added to the Biological Survey collection during the year numbered 1,540, and 908 birds were identified for collections of 63 institutions and individuals in 32 States. Loans from the Survey's collection to 15 institutions and individuals in 8 States aggregated 472 specimens. Biologists of the Bureau using the collection described six new birds of the genera *Otus*, *Strix*, *Glaucidium*, and *Rallus*. A taxonomic revision of the clapper rails (*R. longirostris*) was in press at the close of the year.

As part of a general revision of all squirrels, a taxonomic revision of the red squirrels (*Tamiasciurus*) has continued and is now about half completed. Progress has also been made on a revision of the American wolves (*Canis*), and further study made on the taxonomic relations and distribution of the pumas (*Felis*).

ECONOMIC STUDIES OF WILDLIFE

WATERFOWL FOOD INVESTIGATIONS

IMPROVED CONDITION OF EELGRASS

Improvement in the status of the sea brant, a species dependent to a large extent on eelgrass (*Zostera marina*), may be recorded as a result of the definite gain the eelgrass has made in the past year, following diminution in the wasting disease prevalent along the Atlantic coast. Inspections of eelgrass beds, made during the fall and winter throughout the range of the plant from North Carolina to Maine, have demonstrated healthy new growth from Long Island northward, though these beds have not attained sufficient magnitude to deflect sea brant in any numbers from a direct flight to their most important winter-

ing grounds in New Jersey. In limited areas of reduced salinity, as in the Chesapeake Bay, the new stands have been encouraging. A report (Leaflet BS-94) entitled "Status of Eelgrass on the North Atlantic Coast, January 1937," presents detailed information on the observations and experimental plantings conducted during the year and on the present relative abundance of the plant.

Along the whole of the former eelgrass range in the eastern United States, the continued increase and spread of wigeongrass (*Ruppia maritima*), a submerged aquatic of recognized value as a waterfowl food, is an interesting corollary of the diminution of the eelgrass. Having a high tolerance for salt, wigeongrass can thrive in waters varying from fresh to strongly saline and is serving as an excellent substitute for the eelgrass.

TRANSPLANTING WATERFOWL FOOD PLANTS

Repeated efforts to transplant seemingly healthy Atlantic-coast eelgrass have met with failure. The plantings that were reported last year of the Pacific-coast form have all disappeared except one lot in Plymouth Harbor, Mass, which has a chance of survival since three of the plants have flowered. Because several of the transplantings thrived at first, more were brought from the Pacific coast and set out during February and April in 23 suitable localities from Maine to North Carolina. Some of these have disappeared though others have survived.

Of the various waterfowl foods experimentally propagated in the State of Washington, wildcelery (*Vallisneria spiralis*) alone has proved susceptible of widespread cultivation. Though delta duckpotato (*Sagittaria platyphylla*) and wildrice (*Zizania aquatica*) were successfully grown under controlled conditions, no success attended efforts to grow banana waterlily (*Castalia flava*) in that State. Experimental plantings of both eelgrass and wildcelery made during the spring on the Bear River Migratory Bird Refuge, Utah, have been unsuccessful.

PROPAGATION OF DUCK FOOD PLANTS

The various marsh and aquatic plants have so long been of economic value to man—either directly, as food for himself and his domestic animals, and as materials for building, caning, and basketry, or indirectly, as food for game species—that there has arisen a great variety of local names for them. There has also been much confusion in their scientific names. With the initiation of a program of experimental propagation and transplantation of waterfowl foods and control of their competitors, the need has been recognized for a clear concept of what species is meant by the terminology employed. A Check-list of Marsh and Aquatic Plants of the United States (Leaflet BS-72), issued by the Bureau in December to meet this need, records the scientific and vernacular names of 948 species of 75 families that enter into consideration in the improvement of waterfowl habitats. In addition, much bibliographical work was completed on the growth and reproduction of marsh and aquatic plants under both natural and artificial conditions.

Transplanting the vegetative growth of aquatics promises the quickest and surest method of waterfowl-food propagation under similar local conditions, but as this method is not always practicable other means must often be used. Spring planting of seeds offers intensive possibilities, but the seeds of marsh and aquatic plants are not so readily held over in viable condition as are those of land plants. To obtain a better basis for propagating waterfowl food plants from seeds, investigations of means of harvesting, storing, and germination were carried on during the year. In the fall seeds of 40 of the more desirable species, including 8 pondweeds (*Potamogeton* spp.), 8 bulrushes (*Scirpus* spp.), and 7 smartweeds (*Polygonum* spp.), were collected on various waterfowl refuges throughout the country. To permit the after-ripening that is essential to germination, each of these kinds of seeds was subjected to the following three methods of storage for periods varying from 4 to 6 months: (1) Immersion in water at approximately 36° F.; (2) keeping dry but in damp air at approximately 36°; (3) keeping dry at room temperature. In addition the seeds of a few species were stratified in wet excelsior, and some of these germinated when others, treated according to the first three methods, failed to do so. Simultaneously tests were conducted on the storage requirements of tubers, rootstocks, and vegetative reproductive parts of common marsh and aquatic plants.

WATERFOWL FOODS FOR UNUSUAL SITUATIONS

Though the plant has long been familiar to botanists, the value of the dwarf spikerush (*Eleocharis parvula*) as a waterfowl food has only recently become apparent. Because of its growth habits and small size it is most satisfactory as a food for shoal-water ducks. Though occurring commonly in brackish mud flats and shallow waters, it is widely distributed, hardy, and surprisingly adaptable and will grow in fresh-water marshes. Other duck foods observed to be valuable for unusual situations include tidemarsh acnida (*Acnida canabina*), water-hyssop (*Bacopa* spp.), and rice cutgrass (*Leersia oryzoides*).

FOOD RESOURCES OF REFUGE AREAS

Areas proposed for acquisition as refuges for migratory waterfowl were surveyed as to food resources in the New England States, New York, Georgia, Missouri, Kansas, Montana, Idaho, Wyoming, Arizona, Nevada, Washington, and California, and planting programs were outlined for several. Federal refuges in Georgia, Oklahoma, Oregon, and California were inspected, and experimental plantings were suggested for improving them both for waterfowl and for upland game. Inspections of refuge and sanctuary areas, each involving the preparation of a planting program, were made in Maine, Vermont, Connecticut, New York, Pennsylvania, and Wyoming, in cooperation with the Resettlement Administration, the Forest Service, and the Fort Benning (Ga.) Military Reservation, and for various private interests.

ECOLOGY OF WATERFOWL FOOD PLANTS

The measuring of chemical and physical changes in the famous coastal ducking waters of the South is continuing. The demand for navigation channels and inland waterways, and their increasing use, involve continuous dredging operations, and the resultant joining of formerly unconnected bodies of water by canals causes a progressive alteration of the physicochemical balance in the feeding areas upon which ducks and geese depend. When turbidity or pollution so alters ecological conditions as to menace aquatic food plants of waterfowl this Bureau undertakes to ascertain whether lock construction or other remedial measures are practicable.

That the maintenance of an aquatic flora requires relatively stable environmental conditions was again demonstrated in Currituck Sound, N. C., and Back Bay, Va. Following a hurricane in September 1936 the locks at Great Bridge, Va., were opened, and within a short time increased salinity and pollution were evidenced in the plasmolysis and death of sago pondweed, redhead grass, wigeongrass, and other submerged aquatics. When the locks were again closed the conditions in the sound improved.

Experimental work on the Louisiana coast on the physicochemical optima for aquatic plants was initiated at the Delta Migratory Waterfowl Refuge. The rate of diffusion of chlorides from subsoils through topsoils into impounded waters in areas well supplied with natural salts has been studied in the Bear River Marshes, Utah, to ascertain any possible deleterious effects on the valuable pondweeds.

SUPPRESSING COMPETING PEST PLANTS

Encouraging results have followed the spraying of several sample plots of marsh weeds in 1935 to test the effectiveness and permanency of various chemicals in controlling or eradicating competing and objectionable marsh plants. The work has not yet progressed sufficiently far, however, to permit recommendations regarding spray formulas. Further tests will be made during the coming year.

The introduced alligatorweed (*Althernanthera philoxeroides*), once viewed as a possible waterfowl food, is proving to be a serious pest in fresh and brackish coastal waters from North Carolina to Louisiana. Its relationship to the marsh flora and fauna is now being studied in the Delta Migratory Waterfowl Refuge, La. Though alligatorweed appears to harbor a good animal population, there is little doubt that it is an adventive plant that should be held in check when it tends to choke up water areas and smother valuable food species; it reproduces vegetatively with great ease and matures practically no seed. Since a

piece of broken stem comprising a single node, internode, and leaf axil is capable of producing an entire plant, the practice of mowing or pulling up the plant and throwing it on the shore, or on other masses of vegetation, fosters its chance of survival and spread, instead of destroying it. The only control methods that have thus far proved effective involve the drying out of an area or the rooting out and maceration of the entire plant, since chemical treatments that would destroy the pest would render the area unsuitable for more desirable growths.

MOSQUITO CONTROL IN WILDLIFE HABITAT

Areas in Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, South Carolina, Alabama, Tennessee, Kentucky, Illinois, Missouri, Louisiana, and California were surveyed to determine the effect of mosquito-control ditching operations on wildlife and its habitat and food resources, in order to permit the recommendation of control measures less injurious to marsh-inhabiting species. The control of mosquitoes is necessary to the health and comfort of the population of cities and towns, but in places remote from human habitation it is quite a different matter to drain marshlands, swamps, and ponds and thus lower water tables, develop worthless thickets, and eliminate useful aquatic plants and animals upon which the ecologic balance and the wildlife values of land and adjacent waters depend. Much of the drainage for mosquito control has been undertaken without the guidance and advice of entomologists and biologists and thus has been unnecessarily destructive to game and fur mammals and birds. Under competent supervision, the results have been far less detrimental to wildlife.

The destructive effects of mosquito-control operations on wildlife habitat have been caused chiefly by altering natural water levels beyond the limits that most of the desirable plant and animal forms can tolerate and by lowering the levels of ponds, thus destroying valuable submerged plants by subjecting them to injurious exposure or desiccation. In many instances the lowering or excessive fluctuation of water levels as a result of ditching has led to the elimination of indigenous plant and animal forms and to invasions of undesirable plants that rapidly displace species useful to waterfowl and other valuable wildlife.

Other interested Federal and State agencies have cooperated with the Bureau in experiments concerned with studies of mosquito breeding in different types of ponds and marshes and of control measures not seriously injurious to the valuable flora and fauna. Recommendations have been made that where possible water levels be adequately controlled through the use of sluices, tide gates, and other means, and that mosquito breeding be checked by the use of killifishes, top minnows, and other predatory enemies of mosquito larvae.

In several instances cooperative efforts have resulted in the preservation or partial restoration of marshlands valuable to wildlife. Evidence has been obtained that permanent ponds on salt marshes rarely provide suitable breeding environment for mosquitoes and as a rule need not be eliminated in mosquito-control work. This has resulted in the saving to wildlife of many marsh ponds along the North Atlantic coast and in the restoration of others through the installation of dams in the ditches that formerly drained them.

Biological, chemical, and engineering devices are all being investigated in an effort to solve the wildlife aspects of the mosquito-control problem. In some localities the impoundment of waters on the marsh has been successful. Larvicides, such as pyrethrum, have been found as effective in mosquito control as fuel oil and far less destructive to wildlife. Worth-while progress is being made in this work, but the results have not been unqualifiedly accepted by all mosquito-control workers as alternatives to drainage.

With the cooperation of the W. P. A. many project applications for mosquito control and other drainage operations have been reviewed by the Survey, with the result that some applications have been canceled or the proposed methods of work modified. In many cases, to the satisfaction of all concerned, such modification has resulted in the construction of ponds and other artificial habitat to compensate for the natural wildlife environment unavoidably destroyed by drainage.

Several water impoundments made by the Tennessee Valley Authority, particularly the Wheeler and Wilson Lakes, were inspected during the year preliminary to recommendations for improving food conditions for upland game and waterfowl and to determine what effect mosquito-control operations were having on the wildlife resources of the Tennessee Valley. Effort was made to

assist the Authority in more closely correlating necessary mosquito control with wildlife interests. It was found that much of Wheeler Lake has excellent possibilities for wildlife development, providing compatible methods of mosquito control can be employed. It was recommended that stress be laid upon biological methods of control rather than on the use of oils or other destructive larvicides.

LABORATORY RESEARCH IN FOOD HABITS

Reduced field work and increased laboratory investigations were reflected in a greater total number of wildlife-food analyses made this year. Stomachs were examined of 2,482 birds of 78 species, of 586 mammals of 32 species, and of 282 reptiles of 17 species, in addition to 377 pellets of 8 species of birds and 345 droppings from birds of 1 species and mammals of 4. Interesting additions to the list of species of which food has been analyzed were the trumpeter swan (two stomachs) and the pink-footed goose and large-billed puffin (one each).

REPTILE COLLECTIONS EXAMINED

Stomachs of 510 snakes were collected in 1936 and 1937 on the George Washington National Forest, Va., through the cooperation of the Forest Service, the largest single reptile collection the Bureau has ever received for food analysis. Of these, 258 of 15 species, collected in 1936, have been examined.

Special effort was made to obtain material in spring and early summer, particularly May and June, in order to cover the nesting period of ruffed grouse, as collections during that time are needed to clarify the relationship between snakes and game birds. It is known that black snakes eat the eggs of game birds, but little is known of the effect of this habit on the increase of the species preyed upon. Little authentic information is as yet available on the food habits of rattlesnakes, copperheads, and other snakes, or on the effect these reptiles have on the abundance of game and other wildlife.

Large numbers of snakes are killed on roads and highways each year, and many of the specimens in the present series were salvaged from such casualties. Among other reptile studies initiated, the investigation of the food habits and economic relationships of the cottonmouth moccasin on the Delta Migratory Waterfowl Refuge, La., is of special importance because that species may be an inhibiting factor in the production of waterfowl and muskrats. For use in answering routine correspondence, revisions of two leaflets on reptiles were issued during the year: Poisonous Snakes of the United States (BS–70); and The American Chameleon and Its Care (BS–92).

MAMMAL STOMACHS ANALYZED

Based on the examination of 14,829 stomachs collected in every month of the year in 17 States, a manuscript was completed for publication on the food habits of the coyote. This has been the major work of the Food Habits Laboratory at Denver since its establishment in 1931 and should aid materially in the consideration of any needed modification of policies as to control of this predator.

Examinations of fecal material collected in 1936 on the Biological Survey expedition to the Aleutian Islands made possible the preparation of a report on the food of the comparatively rare sea otter. This animal is a prized fur species and if its numbers can be increased has great economic possibilities. On the same expedition special efforts were made to obtain information on the food and feeding habits of blue foxes, with particular reference to their effect on the abundance of nesting birds. The data thus obtained will influence management policies for the Aleutian Islands Bird Refuge.

FOOD OF BIRDS

To check the dependability of stomach analysis as a method of obtaining evidence of the egg-eating propensities of crows, study of the effect of crow digestion on the shell of hens' eggs was made. Eggshell was force-fed to crows, and autopsies were performed at the expiration of set periods up to 5 hours after feeding. Examinations of alimentary tracts showed that so long as some shell is ingested with the egg, evidence of an egg-eating habit will be present in the stomach and intestine until normally eliminated.

That the barn owl may be a better collector than man has been confirmed by the discovery of remains of the meadow mouse in pellets collected in 1936 on the Cape Romain Migratory Bird Refuge, S. C. Barn-owl pellets collected in South Carolina in 1934 also contained the remains of meadow mice, the first record of the occurrence of the species in the State, despite the fact that interested scientists, after persistent trapping, had failed to reveal the presence there of this small rodent, so common farther south.

Examinations of all the available stomachs of the American coot—totaling 735—have been completed, the information has been tabulated, and a report on the findings is being prepared. The crops and stomach contents of 57 band-tailed pigeons were examined and the data tabulated for use in study and management of this species in California. Much other laboratory work on the food of birds was cooperative in nature and is discussed under the next heading.

A new number in the Survey's leaflet series (BS–84), issued during the year, was devoted to a report on the food habits of the scaled quail. Another Bureau leaflet (BS–19) entitled "Groups of Plants Valuable for Wildlife Utilization and Erosion Control," was revised and published as Circular No. 412 of the Department. Revised lists of dealers in cage birds and cage-bird supplies (Bi–631), dealers in devices for attracting birds (Bi–160), and dealers in peafowl (Bi–1189) were prepared to meet the needs of correspondents.

COOPERATIVE FOOD-HABITS RESEARCH

WILDLIFE ON GEORGE WASHINGTON NATIONAL FOREST

A cooperative food-habits project initiated during the year involved a survey of the available food supplies and a study of the food habits of the game and fur-bearing animals of the George Washington National Forest, Va. Examination of the crops and gizzards of more than 200 ruffed grouse, 5 bobwhite quail, and 72 wild turkeys and of the stomachs of 5 opossums, 22 foxes, and 13 brown bears have been completed. These investigations were made possible through allocation by the Forest Service of Emergency Conservation Work funds for employing three temporary workers for a 3-month period to assist in separating and identifying stomach material. The study will be continued to cover all seasons of the year, especially to ascertain seasonal variations in the food preferences and requirements of game animals. It will be followed by the preparation of illustrated reports on the important foods of each of the major species of game and fur-bearing animals of the forest. The reports will be available to forest rangers and game technicians and will serve as a guide to the management of the resident forest game populations.

WILD TURKEY MANAGEMENT

To encourage and increase valuable wildlife on vast forest holdings the Forest Service has entered into a cooperative agreement whereby this Bureau will study the problem of management of wild turkeys in the Missouri Ozarks, where there are eight national-forest units, comprising 3,500,000 acres. A survey of the results of a 10-year restocking program conducted by the State and a study of the present occurrence and response of the wild turkey to management practices formed the basis for a report on The Wild Turkey on the Missouri Ozark Range (Leaflet BS–77).

Special efforts are now being directed toward establishing a native wild turkey management demonstration in the 14,000-acre wilderness refuge and research area on the Clark National Forest. Part of the tract will be fenced, so that grazing animals can be excluded, and it will provide favorable conditions for a study of the effect of grazing on bird populations. Preliminary findings indicate that grazing and illegal hunting are the prime factors in keeping the wild turkey population at a low level despite its high reproductive rate. In addition to the work in field management, 18 crops and stomachs of turkeys and 6 lots of droppings collected in the Ozark section have been examined.

MISCELLANEOUS STUDIES

Stomachs of 30 opossums, 2 raccoons, 13 weasels, 3 minks, 97 skunks, and 18 feral house cats were examined for a predator study being conducted at the Kellogg Bird Sanctuary, Mich. A series of 24 otter feces and 14 stomachs of the American merganser were examined for the Michigan Department of

Conservation. A total of 153 ruffed grouse crops and stomachs and 125 fox droppings were examined on a cooperative basis for the New York State Conservation Department. In continuation of the cooperative study with the Pennsylvania Board of Game Commissioners on the food of birds killed for bounty, the stomachs of 54 goshawks, 2 red-tailed hawks, and 4 marsh hawks were examined.

A report on the stomach contents of 98 birds of 24 species and of 8 mammals of 6 species collected in Newfoundland, Labrador, and Greenland, during the 1936 Bartlett Expedition, prepared in collaboration with the collector, will be published by the Field Museum of Natural History.

Stomachs of 89 white-tailed deer, collected in several States, were examined for the Forest Service, and those of predators and a number of small birds were examined for the Soil Conservation Service. Other examinations included 56 stomachs of Texas gray squirrels and 33 pellets of 7 species of Iowa owls for institutions or individuals and long series of material for university cooperators and for those in charge of the management of the Bureau's game preserves and migratory waterfowl refuges. In addition, plants were identified to aid in the Bureau's program of migratory waterfowl restoration; seed material was determined for university cooperators in Texas, for the Cooperative Quail Study Association in Georgia, for the Resettlement Administration, and for numerous other organizations and individuals; and assistance was given in identifying several hundred fossil seeds for the University of Iowa.

FIELD INVESTIGATIONS OF INJURIOUS SPECIES

CROW-WATERFOWL RELATIONSHIPS ON BREEDING GROUNDS

Crow-waterfowl investigations, made during the breeding seasons of 1934 and 1935, on three waterfowl nesting grounds in Canada, clarified a number of points with respect to crow depredations on the eggs and young of waterfowl. The results of these studies were published in June in Circular No. 433, of the Department, entitled "Crow-Waterfowl Relationships: Based on Preliminary Studies on Canadian Breeding Grounds." During the last 2 years the studies were extended to the Lower Souris Migratory Waterfowl Refuge, N. Dak. In contrast with the results obtained in 1934–35 in Canada, where the crow was responsible for the destruction of 31 percent of the duck nests under observation, only 1.7 percent of the nest destruction at the Lower Souris Refuge in 1936 was attributable to crows, while 30.6 percent was caused by skunks forced into the lowland nesting areas by drought conditions. In 1937 the situation altered again, and foxes were found to be exacting a considerable toll in restricted parts of the refuge. These studies made evident the danger of sweeping generalizations to justify control operations for the betterment of game. They also indicate that treatment of the control problem may have to be varied not only in different areas but even in the same areas in successive years, depending on the numerical fluctuation and drift of the animal populations.

EUROPEAN STARLINGS

In a leaflet entitled "Suggestions for Combating Starling Roosts" (BS–81) the Bureau recapitulates most of the practical experimental work on starling control thus far undertaken. Some attention was given during the year to perfecting a method of starling control suitable for use in metropolitan areas, where the roosting birds continue to be a troublesome pest. Efforts also are being made to perfect traps suitable for taking starlings. A noticeable reduction in the number of starlings wintering in Washington, D. C., last year, may indicate a tendency of these introduced birds to follow the course of the English sparrow toward a lower level of abundance.

ARMADILLOS IN TEXAS

Field work carried on in Texas at intervals during 4 years on the relation of the armadillo to the nesting of the bobwhite quail has been completed. Tests of armadillo reaction to dummy and genuine quail nests were practically negative, and the indications are that under normal conditions the quail, unless they are present in excessive numbers, are relatively safe from armadillos. An interesting contribution to the biology of the armadillo was the discovery that these animals inflate the intestine with air to enable them to float.

ORIOLES IN NEW YORK

In 1935 reports were received of injury to grapes by Baltimore orioles in New York, and a recurrence of their depredations in 1936 precipitated an investigation. This revealed that the rather extensive damage was due to the flocking of young birds in trees adjoining arbors and orchards, from which they emerged to sample sour cherries, grapes, and apples, until a fruit sufficiently soft and appetizing for complete consumption was found. Many bird-frightening devices used there have been ineffectual and more aggressive measures of control were necessary.

BALDPATES IN WASHINGTON

During a 10-week period, commencing in December, large flocks of baldpates, or American wigeons, invaded the Skagit district in Washington State, in which farmers specialize in growing beet, turnip, and cabbage seeds—crops requiring 2 years to mature. During the exceptionally severe winter the natural feeding areas of these shoal-water ducks were frozen over, thus forcing the birds to search for food elsewhere. At first only the cabbage heads protruded above the snow and these were eagerly seized upon by the ducks, but in feeding they packed the snow down until the turnips, growing between the cabbage rows, also were exposed to their depredations. Through cooperation with State officials, farmers were given aid in protecting their crops under these unusual conditions.

CROP-DESTROYING BIRDS IN CALIFORNIA

Last year, when horned larks were exceedingly destructive to crops in California, the Bureau issued a leaflet (BS–64) on Protecting Crops from Damage by Horned Larks in California, describing methods that in many instances enabled farmers to cope satisfactorily with the birds. This year, with crows and California jays exceedingly destructive, attention has been devoted to adapting to California conditions methods elsewhere found successful in preventing bird depredations. The second part of a cooperative manual entitled "Procedure and Methods in Controlling Birds Injurious to Crops in California" has been prepared for publication by the State, to serve as a reference and guide to bird-control activities in California. Since knowledge of the individual and flock movements of injurious species is essential to the formulation of control policies and procedure, the banding of birds of offending species, including the western mourning dove, tricolored redwing, and the Gambel's, golden-crowned, and Lincoln's sparrows, all of which occasionally cause damage to agriculture, was continued, and in all, 3,193 birds of 16 species were banded. An order issued by the Secretary of Agriculture empowers State authorities in California to carry on necessary control of species of sparrows and blackbirds protected under the new migratory-bird treaty with Mexico.

FISH-EATING BIRDS

With a view to reducing the objectionable activities of birds about fishponds and water reservoirs without resorting to measures involving the death of the birds, a Department leaflet (No. 120) was published during the year entitled "Excluding Birds from Reservoirs and Fishponds." A Bureau leaflet (BS–83) also was issued under the title "Birds in Relation to Fishes," as a revision of a mimeographed paper prepared for the use of the Bureau of Fisheries.

FUR-ANIMAL CONSERVATION AND RESTORATION

INTEREST IN FUR RESOURCES INTERNATIONAL

The aid of the Bureau is being sought by fur-animal research workers and fur farmers abroad as well as in this country. One delegation from Manchuria visited the Bureau during the year to obtain information on the results of experimental work in fur farming. A member of a firm engaged in international fur trade, with headquarters in Germany, also conferred with Bureau officials, particularly on the development of fur farming in this country, including the breeding of Karakul sheep. A representative of the Bureau addressed fur farmers of Canada at Winnipeg, Manitoba, on the Organization of

the Fur-Animal Research in the United States. At the request of the Treasury Department, arrangements were made to detail a Bureau fur specialist for 3 months to investigate in China certain phases of fur importations.

As a supplement to a similar treatise published last year covering a 5-year period, an analysis of the average prices and percentage distribution according to degree of silver of the silver fox skins marketed in the United States and Great Britain was prepared and made available to the various fur publications.

DEMAND FOR INFORMATION INCREASING

To make current information available and to replenish supplies exhausted by an increasing popular demand, a number of mimeographed leaflets pertaining to fur resources and the production of rabbit fur were prepared or revised on such subjects as the following: Raising martens and otters in captivity (BS–63 and BS–75), fur farming in perspective (BS–69), feeding and caring for squirrels (BS–80), sanitation in domestic rabbitries (BS–86), relative weights of young rabbits and does during the suckling period (BS–65), and inheritance of "woolly" in rabbits (BS–73).

The Bureau's contributions to the 1937 Yearbook of Agriculture included an article entitled "The Breeding of Fur Animals," which sets forth accomplishments in the research field, with particular emphasis on the genetics of silver foxes. The need for an extensive program for further research in the reproductive cycles, nutrition, and breeding of various species of fur animals was suggested.

A brief was prepared during the year on the relation of fur farmers to the Social Security Act, and testimony was given by an expert fur witness in litigation involving departmental land-condemnation proceedings in connection with the purchase of certain wildlife refuges.

An encouraging development with reference to conserving fur resources has been an awakened interest on the part of the States and the fur trade. This may be the forerunner of State legislation to require accurate reports by species on the annual catch by trappers. Definite resolutions urging still more effective conservation and restoration of the fur resources were adopted by the fur dealers and conservationists in attendance at the second annual meeting of the North American Wildlife Conference held in St. Louis in March.

PROGRESS IN FUR FARMING

Mink raising continues to be the popular phase of fur farming for beginners in the United States. The production of ranch-raised mink pelts is now estimated to reach 100,000 annually in this country, and the average quality is considered superior to those taken in the wild, primarily because breeders can control the stock and make selective matings. Current information was made available by the Survey in a new leaflet, Mink Raising (BS–82).

Fox-farming operations are in a healthy condition, and some expansion has been noted. Bureau records show that approximately 40 percent of all silver fox pelts now produced in the United States are full silvers and that each of the past 6 years has shown an increased percentage of full silvers, primarily because on the average they command prices as much as 45 percent higher than the three-quarter silvers. Breeders are showing increasing interest also in polygamous matings of foxes, a practice studied by the Bureau and reported upon in a leaflet (BS–66).

A study was made of the auction sale price of more than 10,000 silver fox skins produced by one breeder in 1935 under similar feeding and environmental conditions, revealing that pelts from male pups sold for 8 percent more than those from female pups and that in pelts from mature animals the difference in price due to sex was 16 percent in favor of male skins. The primary cause of this price differential is the larger size of the male skin. Pelts from pups in some cases sold higher than those from mature animals.

To offset the increasing prices of raw meat, emphasis is being placed upon economies that will not affect fur quality. The interest that fur farmers are showing in the solution of their problems is reflected in the establishment of fur-animal experiment stations in Colorado by breeders in the Rocky Mountain section, in Oregon by the State Agricultural College, and in Canada, where several Provincial fur-animal stations have recently been organized.

Though most of the fur-farming operations are confined to the fine-furred animals—foxes and minks—interest also is being shown in fishers and other

fur bearers. Either unsatisfactory reproduction in captivity or high rearing costs in relation to pelt prices, or both these factors, have been limiting the extension of fur farming to other species.

Raising domestic rabbits for food and fur has received a stimulus from advancing prices, and raising rabbits for laboratory purposes is still found profitable by many breeders. An unsatisfied demand for domestic rabbits suitable for making pneumonia serum has had an encouraging effect on rabbit raising. The Angora rabbit wool produced in the United States also seems to have found a more extensive and dependable market.

RESEARCH IN COOPERATION WITH OTHER AGENCIES

The popularity of Persian lambskins for use in coats and trimming has stimulated activity in Karakul sheep raising in this country in both purebred and grade flocks. Karakul sheep investigations in cooperation with the Bureau of Animal Industry are progressing satisfactorily. Assistance was given by representatives of the Survey in selecting a more complete and comprehensive set of standard sample skins for classifying the experimental Karakul skins as well as live lambs retained for breeding. All skins taken during previous years were reclassified in accordance with the new standards.

Some material for the embryological studies of fur animals in cooperation with the Carnegie Institution of Washington was collected during the year but little was accomplished in studying it, for lack of facilities.

For an investigation of what constitutes a dressed fur skin, undertaken in cooperation with the Bureau of Standards, 72 rabbit skins from the United States Fur Animal Experiment Station were supplied.

A cooperative agreement was drawn up between the Bureau of Chemistry and Soils, which investigates tanning in all phases, and the Bureau of Biological Survey to investigate the influence of breeding, sex, age, season, and environment as factors affecting the quality of raw and tanned furs. Active work will be begun during the coming year.

In cooperation with the Tariff Commission through the Department of State a detailed survey was made of fur resources and fur-manufacturing operations in several foreign countries. The resulting information in the files of the Bureau gives an opportunity of correlating this country's activities with world trends.

An investigation into the relative efficiency of various types of traps was conducted during the year in cooperation with a leading manufacturer. The primary purpose was to obtain information useful in conducting future fur-animal investigations and for control work on refuges and in the field.

The cooperative study with the research department of a large hat corporation on the value of jack rabbit and cottontail fur from various sections of the United States, as a basis for felt-hat making, was completed during the year. Several sample hats were made up entirely of these furs as well as in various blends. The best hat was made from the fur of the Nebraska white-tailed jack rabbit, with blacktails second, and cottontails a poor third. Though a fairly satisfactory hat can be made from these furs exclusively, much superior hats are manufactured from blended furs. Jack rabbit fur has been used for some time in the hat trade, but this study has established the relative value of skins from species from different sections of the country. The findings have been set forth in a manuscript entitled "Utility Value of Jack Rabbit and Cottontail Skins." Similar cooperative research will be extended to other native mammals and to domestic rabbits.

FUR ANIMAL EXPERIMENT STATION

To give to the experimental program a permanence that cannot be attained on rented land, Congress appropriated $21,500 for purchase of the site of the United States Fur Animal Experiment Station, in the Adirondack section, and for construction of needed buildings. The deed was recorded on December 4. Plans and specifications were drawn up by Bureau officials for remodeling the residence and erecting a new office building, a carpenter shop, utility buildings, and a slaughterhouse of uniform design, though the whole program cannot be accomplished with present available funds. The mink shed and furring shed were moved from a site near the highway to make space for the new office building, the construction of which was progressing at the end of June. A commodious and easily accessible parking space was provided for the numerous visitors to the station.

In addition to giving personal information to the increasing number of visitors, the director addressed various other groups and organizations and prepared informational material for the daily press and popular articles on the results of feeding experiments at the station, at the request of publishers of fur-farming journals in the United States and in Canada and other countries.

FOXES

The birth of an abnormally small number of desirable female fox pups last year made it impracticable to cull the breeding stock as closely as desired, but some progress was made, and during the coming year all Alaskan silvers will be eliminated, leaving only the Standard breed in use in experimental work at the station. During the gestation and lactation periods foxes fed rations containing 40 percent of raw meat (on the basis of added water) responded as satisfactorily as those fed rations containing 60 percent. Previous experiments had shown that tankage (4 parts) with liver meal (1 part) was not a satisfactory substitute for the raw-meat portion of the summer and fall ration of adult foxes. This year's experimental work with adults shows that when 10 percent of the ration as fed is composed of raw meat, tankage and liver meal are as satisfactory as beef meal in summer and fall. Weaned pups were fed until pelting time rations in which the raw meat was entirely replaced by an equivalent quantity (on the dry basis) of beef meal (5 parts) and liver meal (1 part). These substitutes were somewhat more economical than the raw meat, but the pups did not make quite as much growth as those fed raw meat. Experts in the fur trade differed as to the effect of these rations on the quality of the pelt—one was of the opinion that pelts from animals fed raw meat showed more sheen and fur growth, while the other could see little difference between the two. Since a cheaper ration may be responsible for a pelt so inferior as to more than offset the saving involved, this point will receive further consideration.

Pieces of block salt were placed in several fox pens for a period of several months, but careful periodic weighings showed that none of it was consumed by the foxes. Either foxes do not require salt or else the rations contained enough to satisfy their requirements. Little progress was made in artificial insemination of foxes.

Toward the close of the year fox-feeding experiments were in progress to determine the results of adding a small quantity of liver meal to the beef meal in the summer and fall feeding of male foxes and of using soybean meal as a partial substitute for dehydrated beef meal for adult vixens. Preliminary tests were made to determine also the desirable proportions of peanut meal and fish meal to replace dehydrated beef meal in the summer feeding of vixens. Information is now being sought on the desirability of using equal parts of dehydrated beef meal and soybean meal as a complete substitute for raw meat in the ration of weaned fox pups when some are to be pelted.

MINKS

During the second year of definite feeding experiments on minks, most unsatisfactory results were obtained in substituting frozen codfish for raw meat in the ration of weaned kits during summer and fall. Other kinds of frozen fish have proved satisfactory to commercial ranchers.

Contrary to general expectations, a group of adult female minks that received a ration having 50 percent of raw meat (on the basis of added water) during breeding, gestation, and lactation periods whelped more litters and raised more kits to weaning than did those that received a ration having 65 percent of raw meat, but neither group produced satisfactorily.

MARTENS

The most serious problem confronting marten raising is concerned with satisfactory reproduction. Only one litter of two young was obtained from eight adult females, though males were given several mates and females were allowed service by more than one male.

RABBIT EXPERIMENT STATION

The widespread interest in the Bureau's research in the rabbit-raising field was shown on two occasions during the year: A field-day meeting for rabbit

breeders, held at the United States Rabbit Experiment Station, Fontana, Calif., in April, was attended by nearly 500 persons, representing 5 counties and 67 cities and towns; another meeting was attended by representatives of 15 milling concerns who wished to obtain the latest information from the feeding experiments conducted at the station. Similar evidence of the public service given by the station is found in the increased correspondence from rabbit raisers.

New and practical equipment developed by the station staff has included a simple and inexpensive screen box for protecting young litters from the time of kindling to the age of 12 to 14 days, thereby eliminating the nest-box heat mortality that has been a disturbing factor in previous experimental work. The nail keg nest box described in Leaflet BS–74 has proved so satisfactory that it has replaced all other types used in the Bureau's experimental work.

FEEDING TESTS

The experimental program at the station was materially extended during the year, and on the average about 1,000 animals were employed in various breeding and feeding tests. At the national convention and show of the American Rabbit and Cavy Breeders Association, held at Fort Wayne, Ind., in November, the director of the station presented the results of tests over a 2-year period with a self-feeder designed by the station staff. The facts, together with detailed drawings for accurate construction, were later incorporated in a Bureau leaflet (BS–85), Self-Feeding System for Market Rabbits. This almost revolutionary method of feeding domestic rabbits has not only lessened the feed cost per pound of live weight but also has materially increased the rapidity of gain. Numerous commercial rabbit raisers have already installed this system with satisfactory results. Use of the self-feeder also makes it possible for a doe of superior heritage to care for a large litter and increase their weight before they come out of the nest box and begin to eat. The station has consequently been more successful in identifying and segregating those animals having superior germ plasm. Feeding experiments have shown that a plant-protein supplement is essential for rapid and economical gains in rabbits and that milo is a rabbit's first choice of the grain sorghums, though little preference is shown among the other kinds.

Salt-consumption records were obtained over a 1-year period for 10 mature bucks and 43 producing New Zealand does and their litters put on a ration of whole oats, barley, milo, wheat, pelleted plant-protein meal, alfalfa hay, and green feed. During this period the bucks consumed on the average 0.088 pound of salt and the does and their litters 0.195 pound. Based on this test it has been recommended that one-sixth pound of salt be added to each 100 pounds of concentrated feed to supply the rabbit's salt requirements.

THE PROBLEM OF FEEDING AND BLOAT

The problem of bloat, or enteritis, in rabbits, is still unsolved despite a careful and extended program of nutritional research during the year. It was found that hybrid vigor incident to crossing the Champagne d'Argent breed with the New Zealand breed is not a factor in preventing mortality from this cause, and a careful and extensive study of the station records establishes the fact that there is no correlation between mortality and inherited susceptibility or resistance. Experiments have shown that there is no merit in frequently changing the ration in controlling mucoid enteritis, and that whole barley as the sole concentrate is not a direct cause of loss. Experiments were initiated during the year for obtaining information as to the effect of various vitamins on this problem. Better control of bloat is essential before the best results from feeding experiments can be obtained.

IMPROVING MEAT AND FUR QUALITY

Much information has already been recorded on the feeding requirements of medium-size rabbits, as well as of giant and small breeds, the purpose being to formulate feeding standards for rabbits as definite as are already available for other types of livestock.

Representative pelts of fryer rabbits produced by the self-feeding plan were graded by dealers in raw rabbitskins and by other experts after dressing the natural long hair. The possibilities of increasing the percentage of fryer-

rabbit skins usable in the fur trade is involved and has much practical value because of the higher prices now being paid for skins.

Trial express shipments from California to the east coast of frozen rabbit meat wrapped in paraffined cartons and packed in solid carbon dioxide arrived in excellent condition.

BREEDING EXPERIMENTS

An extensive experiment to develop dependable information on the duration of the false pregnancy period of domestic rabbits was practically completed during the year. This required 175 junior New Zealand white does, 4 vasectomized New Zealand red bucks, and 25 New Zealand white bucks. After the doe was served by the vasectomized buck a second mating was permitted by a normal buck to one group after 24 hours had elapsed and to other groups at 24-hour intervals. Definite information on the extent of the false pregnancy period will guide commercial rabbit raisers in their test-mating program in obtaining maximum production.

In October, Department Circular No. 410 was issued under the title "Results From Breeding Rabbits That Are Suckling Young," reporting on experiments conducted at the station over 3 years.

WILDLIFE DISEASE CONTROL

RELATIONSHIP OF DOMESTIC STOCK AND WILDLIFE

Specimens of game and other animals found diseased or dead on various ranges used jointly by domestic stock and wildlife have been studied to ascertain the nature and extent of any possible injurious effects of one type on the other. Grazing animals when present in numbers on a big-game range jeopardize the health of the wild ruminant mammals. Likewise, the maintenance of flocks of domestic poultry on areas frequented by game birds is a potential menace to the wild species. On the other hand, certain parasites have been acquired by domestic stock from association with wildlife. Investigations show, however, that the danger is far greater of passage of disease organisms from domestic herds and flocks to wild species concentrated under management. A paper on this subject was presented by a representative of the Bureau at the second North American Wildlife Conference and is being published in the proceedings for 1937.

In cooperation with the Bureau of Animal Industry, investigations have been made of a situation in Florida, where deer are serving as carriers of tick fever and have been found to be heavily infested with the tropical variety of the fever tick. Research is in progress to ascertain whether parasitized deer are frequent victims of tick fever and also whether they may be affected by or serve as carriers of anaplasma infections, which weaken the hosts by destroying red-blood corpuscles.

Miscellaneous Publication No. 270 entitled "Post-Mortem Examinations of Wild Birds and Mammals," giving directions for use in the study of wildlife diseases, was published during the year.

POLLUTION PROBLEMS

Efforts have been increased to gather information on the various phases of water pollution as it affects wildlife, especially waterfowl, and on possibilities for their reduction. Research to solve problems connected with lead-shot deposition in waterfowl areas, which is one of the most serious forms of pollution, has included surveys to ascertain the localities most affected and cooperation with the University of Minnesota in the development of a nontoxic pellet suitable for ammunition purposes. Progress has been made in compounding metallic alloys that would not poison birds that pick them up when feeding in such areas, and if these alloys are found a practical substitute for lead shot, thousands of birds may be saved from death from lead poisoning.

DISEASES OF FUR ANIMALS

Disease among fur animals is still a serious obstacle to success in fur farming. While many ranches have fared well others have experienced excessive losses from infectious outbreaks. Among the diseases taking heavy toll among silver foxes is that of canine distemper. This infection, however, as-

sumes distinctly different characteristics in foxes than in dogs, and the method of treatment must be considerably modified. Farmers' Bulletin No. 1777, entitled "Diseases of Fur Animals", in press at the close of the year, deals with this subject at length. Mimeographed leaflets to aid in combating disease outbreaks, where rabbits are raised for food and fur, have been issued as follows: Vent Diseases of Domestic Rabbits (BS–79), Sanitation in Domestic Rabbitries (BS–86), Infectious Myxomatosis of Domestic Rabbits (BS–89), and Hemorrhagic Septicemia of Domestic Rabbits (BS–90).

ACQUISITION OF LANDS FOR REFUGES

The program of wildlife-refuge land acquisition (table 2) has continued with the funds remaining from the $6,000,000 appropriation made available for the purpose by act of Congress approved June 15, 1935. On refuges being purchased under emergency funds, 1,050 miles of refuge boundaries, 1,084 miles of necessary auxiliary lines, and 222 miles of level lines were surveyed during the year. Survey descriptions and accurate maps for all completed surveys were prepared concurrently with the completion of the field work.

For real control and conservation, the nature and habits of wildlife make it necessary to have in Federal ownership all lands within the prescribed exterior limits of the refuges established. The requirements of wild birds and mammals and the special nature of the habitats attractive to wildlife limit the opportunities to acquire and restore suitable refuges. A further check on speedy accomplishment of the refuge program within the financial limitation is that title to most of the lands being acquired must be perfected to the satisfaction of the Attorney General by legal action by the vendors or in their behalf or by judicial proceedings in the Federal courts. Numerous proceedings looking to the acquisition of lands by judicial methods were instituted and some of them completed to quiet imperfect titles to lands previously taken under purchase contract and to effect the acquisition of lands on which price agreements could not be reached with the owners.

At a meeting of the Migratory Bird Conservation Commission held on January 12, 1937, lands in 34 units, involving 236 cases and aggregating 134,655 acres, were approved for purchase. The total expenditure involved was $1,408,737, representing an average cost of $10.46 per acre. Most of the lands thus approved for purchase fall within units previously in part acquired under the provisions of the Migratory Bird Conservation Act or for migratory waterfowl refuge purposes through the Resettlement Administration. The following deserve special mention:

The Montezuma Migratory Bird Refuge in Seneca County, N. Y., though relatively small, is exceedingly important because of its situation in a highly developed agricultural section in which most of the natural waterfowl habitat has long since been preempted for agriculture.

The Aransas Migratory Waterfowl Refuge, of approximately 46,000 acres situated on the shores of the Gulf of Mexico in Aransas County, Tex., has been used up to this time for grazing purposes but is now dedicated to the conservation of migratory waterfowl and incidentally of other valuable species of wildlife.

For the Back Bay Migratory Waterfowl Refuge, in Princess Anne County, Va., one of the greatest concentration points on the eastern seaboard of waterfowl in their fall migrations, approximately 3,800 acres of land and extensive bodies of intermingled water were approved for purchase. To this original nucleus will be added other lands equally valuable and essential to a well-rounded-out refuge project.

In the Charles Sheldon Antelope Refuge, Nev., which was established by Executive order of December 21, 1936, approximately 18,000 acres of privately owned lands so distributed as to control the water resources essential to the antelope that frequent it are being acquired. Privately owned lands controlling the water resources for antelope on the Hart Mountain Game Range, Oreg., also are in process of acquisition by purchase.

The nucleus for the Patuxent Research Refuge, Md., originally acquired by the Resettlement Administration, was found better suited for wildlife purposes than for the Greenbelt suburban resettlement project, and by Executive order the Biological Survey was given jurisdiction over 2,693 acres. An extension was necessary to bring the unit to maximum usefulness, and 418 acres contained in 8 tracts are being acquired.

TABLE 2.—*Land for refuges and related uses acquired or in process of acquisition during the fiscal year 1937 under the Migratory Bird Conservation Act, with emergency and other funds, by gift, and by Executive order*

State and county	Refuge	Under Migratory Bird Conservation Act			With emergency and other funds			Acquired other than by purchase	Total	Acquired in previous years
		Acquired by purchase	Pending title conveyance	Total	Acquired by purchase	Pending title conveyance	Total			
		Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Alaska: Third judicial division	Chitina				1		[1] 1		1	
Arkansas:										
Mississippi	Big Lake				80		[1] 80		80	9,299
Arkansas, Desha, Monroe, and Phillips.	White River				22,420	12,927	[2 3 4] 35,347	[5] 714	36,061	64,645
California: Colusa and Glenn	Sacramento				10,776		[3 4] 10,776		10,776	
Delaware: Kent	Bombay Hook	5,120	6,886	12,006					12,006	
Florida:										
Levy	Cedar Keys							[6] 155	155	224
Jefferson, Taylor, and Wakulla	St. Marks	1,155	7,199	8,354	9,473	1,180	[2] 10,653		19,007	36,516
Georgia:										
Charlton, Clinch, and Ware	Okefenokee	288,417	5,396	293,813				[5] 2	293,815	
Chatham	Savannah River (see also South Carolina).	944		944		1,600	[2 4] 1,600		2,544	2,997
Idaho:										
Jefferson	Camas	1,356	8,831	10,187					10,187	
Canyon	Deer Flat	73		73					73	10,179
Blaine, Cassia, Minidoka, and Power	Minidoka							[6] 12,092	12,092	13,240
Bannock	Pocatello, Biological Survey Supply Depot.	1	1	2					2	
Illinois:										
Mason	Chautauqua				5	2,203	[4] 2,208		2,208	2,198
Carroll, Jo Davies, Rock Island, and Whiteside.	Upper Mississippi (see also Iowa, Minnesota, and Wisconsin).									19,630
Iowa:										
Kossuth	Union Slough		864	864					864	
Allamakee, Clayton, Clinton, Dubuque, Jackson, and Scott.	Upper Mississippi (see also Illinois, Minnesota, and Wisconsin).									29,827
Louisiana:										
Plaquemines	Delta	29,966	4,073	34,039		10,361	[2] 10,361	[6] 2,927	47,327	1,408
Cameron	Lacassine	17	8,107	8,124		22,992	[2] 22,992		31,116	
Do	Sabine Lake					139,249	[2] 139,249		139,249	
Maine: Washington	Moosehorn	684	10,609	11,293					11,293	
Maryland: Anne Arundel and Prince Georges.	Patuxent		418	418				[6] 2,693	3,111	
Michigan: Schoolcraft	Seney	3,036	41,906	44,942	826	13,982	[2 3 4] 14,808		59,750	14,800

Minnesota:										
Marshall	Mud Lake				60,216		[4] 60,216		60,216	
Aitkin	Rice Lake	661	1,430	2,091		7,786	[4] 7,786		9,877	
Cottonwood	Talcot Lake					920	920		920	80
Becker	Tamarac	14,390	2,599	16,989					16,989	5,049
Houston, Wabasha, and Winona	Upper Mississippi (see also Illinois, Iowa, and Wisconsin).	1		1		1,925	[7] 1,925	[6] 4,345	6,271	22,370
Mississippi: Washington	Yazoo	1,803	637	2,440					2,440	
Missouri:										
Holt	Squaw Creek	170	1	171	1,933	168	[2 3 4] 2,101		2,272	4,381
Chariton	Swan Lake	2,134	3,223	5,357	5,130	329	[2] 5,459		10,816	1,520
Montana:										
Ferguson, Garfield, McCone, Petroleum, Philips, and Valley.	Fort Peck							[6] 970,000	970,000	
Philips	Lake Bowdoin					640	[2] 640		640	15,400
Roosevelt and Sheridan	Medicine Lake				2,386	7,308	[2 3 4] 9,694		9,694	13,328
Beaverhead	Red Rock Lake		1,003	1,003	1,911	10,709	[2] 12,620		13,623	12,515
Nebraska:										
Garden	Crescent Lake				1,847		[2] 1,847		1,847	40,782
Cherry	Fort Niobrara		377	377					377	18,160
Do	Valentine				16,392	8,252	[2 3 4] 24,644		24,644	43,388
Nevada:										
Humboldt and Washoe	Charles Sheldon (jointly held)		17,984	17,984					17,984	525,000
Washoe	Charles Sheldon (exclusively held).									34,235
Elko and White Pine	Ruby Lake		28,493	28,493					28,493	
New Mexico:										
Chaves	Bitter Lake	2,153	7,775	9,928					9,928	320
Socorro	Bosque del Apache	52,843	2,928	55,771					55,771	
New York: Seneca	Montezuma		2,565	2,565					2,565	
North Carolina:										
Hyde	Mattamuskeet		541	541					541	49,925
Dare	Pea Island	1,539	4,307	5,846					5,846	
North Dakota:										
Foster and Stutsman	Arrowwood				2,036	1,483	[2 3 4] 3,519		3,519	9,792
Burke and Ward	Des Lacs	40	2	42	1,879	1,413	[2 3 4] 3,292		3,334	10,700
Ramsey	Lake Alice		8	8					8	
Walsh	Lake Ardoch				291		[8] 291		291	
Burleigh and Kidder	Long Lake				591		[8] 591		591	6,461
Burke and Mountrail	Lostwood	291	202	493	11,059	3,050	[2 3 4] 14,109		14,602	9,204
Bottineau and McHenry	Lower Souris	6,362	9,635	15,997	6,655	3,763	[2 3 4] 10,418		26,415	31,887
Sargent	Storm Lake				2		[8] 2		2	
Do	Tewaukan				80		[8] 80		80	
Renville and Ward	Upper Souris	160	1,078	1,238	1,146	1,215	[2 3 4] 2,361		3,599	27,359
Oregon										
Lake	Hart Mountain	22,163	11,382	33,545					33,545	[9] 181,971
Harney	Malheur:									
	Blitzen Unit	685	760	1,445					1,445	64,717
	Malheur Unit		317	317	3,031	141	[3 4] 3,172		3,489	90,315
Marion	Willamette		343	343					343	

See footnotes at end of table.

TABLE 2.—*Land for refuges and related uses acquired or in process of acquisition during the fiscal year 1937 under the Migratory Bird Conservation Act, with emergency and other funds, by gift, and by Executive order*—Continued

State and county	Refuge	Under Migratory Bird Conservation Act			With emergency and other funds			Acquired other than by purchase	Total	Acquired in previous years
		Acquired by purchase	Pending title conveyance	Total	Acquired by purchase	Pending title conveyance	Total			
		Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
South Carolina:										
Charleston	Cape Romain		15	15					15	59,906
Jasper	Savannah River (see also Georgia).		617	617	2,015	756	[2 3] 2,771		3,388	4,062
South Dakota:										
Bennett	Lacreek				3,962	81	[2 3 4] 4,043		4,043	5,320
Charles Mix	Lake Andes				2	18	[2] 20		20	343
Brown	Sand Lake				4,401	1,294	[2 3 4] 5,695		5,695	14,038
Day	Waubay	268	40	308					308	2,326
Tennessee: Lake and Obion	Lake Isom					1,402	[2] 1,402		1,402	20
Texas:										
Aransas and Refugio	Aransas		45,917	45,917					45,917	
Bailey	Muleshoe	2,155		2,155	2,214	1,440	[2] 3,654		5,809	
Utah: Box Elder	Bear River		42	42					42	51,793
Virginia: Princess Anne	Back Bay		3,777	3,777					3,777	
Washington:										
Spokane	Turnbull	1,963	10,274	12,237					12,237	
Pacific	Willapa Harbor	548	1,717	2,265				[6] 626	2,891	
Wisconsin:										
Brown	Long Tail Point							[6] 103	103	
Buffalo and Trempealeau	Trempealeau					5,501	[4] 5,501		5,501	707
Buffalo, Crawford, Grant, Lacrosse, Trempealeau, and Vernon.	Upper Mississippi (see also Illinois, Iowa, and Minnesota).					300	[7] 300	[6] 42	342	71,103
Wyoming: Teton	Elk Refuge	5,386	6,790	12,176				[6] 3,165	15,341	[10] 4,518
Total		446,484	261,069	707,553	172,760	264,388	437,148	996,864	2,141,565	(11)

[1] National Industrial Recovery Act.
[2] Federal Emergency Relief Administration and Resettlement Administration funds.
[3] $1,000,000 fund provided through Executive Order No. 6724, of May 28, 1934.
[4] $950,000 fund, a substitute for Executive Order No. 6724.
[5] Acquired by gift.
[6] Set aside by Executive order or proclamation.
[7] Upper Mississippi River Wildlife and Fish Refuge fund.
[8] North Dakota land purchase fund.
[9] Revised acreage.
[10] In addition to the acreage shown, 3,082 acres are held under lease.
[11] Total omitted, as entries in column are for only those refuges on which acquisiton work was involved during the year.

NOTE.—1-acre items range from a fraction of an acre to 1.49 acres.

Union Slough Migratory Waterfowl Refuge, in north-central Iowa, while containing only 864 acres, constitutes an important link in the Mississippi Valley flyway. The peculiar nature of the ownership and the relatively high value of the lands involved, situated as they are in a highly developed agricultural section, have presented problems in acquisition, but the project is being consummated with the active cooperation of the State.

MIGRATORY-WATERFOWL RESTORATION PROGRAM

Progress in the program of migratory-waterfowl restoration has resulted in materially increasing the acreage of suitable land and water habitat. Emphasis this year, however, has been on physical and biological rehabilitation to bring the refuges to their highest carrying capacity for wildlife. Under the guidance of hydraulic engineers water-impoundment structures have been placed on all refuges suitable for flooding. Wildlife technicians have supervised the planting of tons of duck-food plants and of millions of food-bearing trees and shrubs to make the areas further attractive to wildlife. The results have been gratifying and the waterfowl productivity of the many nesting refuges in the Great Plains already has increased three to five times over what it was under natural conditions. Their upland game and fur resources also have been correspondingly built up. It is now demonstrated that methods adopted in the restoration program are a practical success. Reconnaissance surveys over the entire refuge system have shown increased utilization by waterfowl and have demonstrated the need for further acquisition and development of refuge sites at certain gaps in the principal flyways of these migrants.

REFUGE RESTORATION AND DEVELOPMENT

CIVILIAN CONSERVATION CORPS COOPERATION

On the average 24 C. C. C. camps, comprising a total of approximately 4,000 men, were engaged during the year in wildlife-conservation work on 27 refuges in breeding grounds, along migration routes, and in wintering grounds of migratory birds, as well as on ranges of big game and in areas that produce fur-bearing animals.

One camp supervised by the Survey developed a research center at Lake Okoboji, Iowa, for the cooperative study of wildlife problems; a large detachment from a Forest Service camp built fresh-water ponds and improved administrative facilities at the Cape Romain Refuge in South Carolina; and another detachment began cooperative work with the Utah Fish and Game Department for impounding fresh water at the mouth of the Weber River to eliminate waterfowl mortality from botulism in the vicinity of the Bear River Refuge.

New camps were established on the following refuges: The Sacramento Refuge, Calif., known to many sportsmen and naturalists as the Spalding Ranch; the Okefenokee wilderness area in Georgia, where a tract of approximately 300,000 acres has recently been made a refuge; Tamarac Refuge, Minn., a beautiful wooded bird haven; Medicine Lake Refuge, in the plains of eastern Montana; and Lacreek Refuge, unique in an arid section of South Dakota because of its wonderful supply of spring water.

The vital relationship of the conservation, use, and control of water to the successful functioning of refuges has received special attention in the work of the year. Biologists have cooperated with engineers to plan the dams, dikes, and water-control structures that have been built by C. C. C. enrollees to restore the areas to a condition most favorable for wildlife. Each area was studied to determine its peculiar deficiencies and the special measures required to overcome them. Along the eastern coast, fresh-water ponds were provided as they are a great attraction where salt water is predominant. In coastal marshes, water levels were stabilized to the great benefit of vegetation and dependent animal life; and in dry areas of the West, reservoirs were constructed to conserve the spring run-off for maintenance of nesting and feeding marshes.

In addition to improving water facilities the C. C. C. job has included the construction of nesting islands ranging from three-quarters of a mile in length down to the small muskrat-lodge type. Some are grassy for duck and shore-bird nesting; some are gravelly landing bars for geese; and a few are rocky to attract gulls, terns, cormorants, and other birds. Not only do these islands furnish ideal nesting sites, relatively safe from predators, but they serve also as wave breakers to protect shore lines from erosion and favor the growth of aquatic food plants.

The planting in tremendous quantity of marsh and aquatic vegetation and of shrubs, vines, and soil-binding grasses has also been an important accomplishment, both in increasing wildlife productivity on refuges and in decreasing soil erosion. During the year, more than a million trees were set out by C. C. C. enrollees, primarily to provide windbreaks and wildlife cover, and secondarily to landscape refuge headquarters sites.

To supplement the natural vegetative cover, which on many of the refuges has not yet recovered from long periods of unrestrained erosion, hundreds of shelters of various types were erected for winter protection of upland game birds and mammals. Many were of the lean-to type, others in the form of tepees, and some of the open-brush-pile variety. Food and cover-producing shrubs and vines planted nearby will be serviceable later.

To facilitate refuge management, truck trails, bridges, lookout towers, fire lanes, telephone lines, small headquarters and utility buildings, and seed- and tuber-storage cellars have been constructed, and to keep out livestock and prevent trespass, fences and boundary markers have been erected. The gathering and planting of aquatic seeds and tubers, stream and lake-bank protection, soil conservation, general clean-up, and salvaging of old buildings are other contributions of the C. C. C. enrollees to the program of refuge improvement.

The third year of C. C. C. activities under technical supervision of field agents of the Bureau finds refuge areas showing a remarkable physical transformation, especially in the West, where now, covered with mantles of protective vegetation and having stabilized water areas, they stand out in marked contrast to the eroded dry lands that surround them. The following tabulation presents in detail the varied nature and the extent of the accomplishments by the C. C. C. camps during the year, which are exclusive of work done by regular employees on other refuges:

Structural improvements:		
Bridges:		
Foot	number	4
Vehicle	do	33
Buildings:		
Lookout towers	do	9
Bathhouses	do	3
Cabins, patrol houses, and dwellings	do	21
Garages, barns, and service and other buildings	do	98
Cribbing, including filling	cubic yards	1,110
Fences	rods	211,395
Guardrails	do	284
Power lines	miles	10
Sewage and waste-disposal systems:		
Disposal beds	square yards	2,640
Disposal tanks and pools	number	4
Sewer lines	feet	5,973
Telephone lines	miles	89
Water-supply systems:		
Open ditches	feet	2,650
Pipe or tile lines	do	16,145
Springs, water holes, small reservoirs	number	9
Wells, including pumps and pumphouses	do	6
Other improvements:		
Camp fireplaces	number	11
Cattle guards	do	27
Portals	do	7
Signs, markers, and monuments	do	952
Stone walls	rods	82
Table and bench combinations	number	20
Miscellaneous	do	53
Transportation improvements:		
Roads:		
Foot trails	miles	7
Truck trails	do	380
Quarrying limestone	tons	19,647
Crushing	do	18,189
Hauling	do	21,505
Erosion control:		
Stream and lake bank protection	square yards	91,996
Treatment of gullies:		
Bank sloping	do	154,006
Seeding and sodding	do	5,175
Tree planting	do	1,000
Check dams	number	18
Terracing, seeding, and sodding	square yards	18,930
Sheet erosion planting	acres	10
Miscellaneous	man-days	1,807
Fire suppression and fire-hazard reduction:		
Fighting forest fires	do	10,221
Firebreaks	miles	187

Fire suppression—Continued.		
Fire-hazard reduction:		
Roadside	miles	3
Other	acres	1,330
Fire prevention	man-days	776
Recreational and demonstration area development:		
Beach improvement	acres	4
Fine grading, road slopes, etc	square yards	52,774
General clean-up	acres	3,868
Landscaping, undifferentiated	do	60
Obliteration:		
Roads	miles	3
Borrow pits, dumps	man-days	353
Parking areas and parking overlooks	square yards	9,655
Public camp- and picnic-ground development	acres	24
Razing undesirable structures	number	4,995
Soil preparation	acres	334
Walks, concrete, gravel, cinder, etc	feet	2,316
Water conservation:		
Clearing and cleaning:		
Channels	square yards	1,156,598
Reservoir sites	acres	769
Dams, impounding and diversion:		
Concrete	cubic yards	6,795
Fills, earth	do	220,199
Fills, rock	do	4,551
Masonry	do	1,183
Riprap	square yards	8,436
Steel	pounds	79,475
Excavations, earth	cubic yards	77,076
Excavations, rock	do	2,155
Levees, dikes, and jetties	do	1,799,356
Excavation of channels, ditches, and canals	do	687,500
Lake and pond development	man-days	31,033
Pipe lines and conduits	feet	2,486
Riprapping or paving:		
Rock or concrete	square yards	62,503
Brush or willows	do	35,526
Water-control structures, other than dams	number	57
Concrete or masonry	cubic yards	2,232
Wood	feet	269,796
Wildlife habitat improvement:		
Field planting or seeding (trees)	acres	31
Food and cover planting and seeding	do	5,507
Nurseries	man-days	8,193
Moving and planting trees and shrubs	number	953,906
Seed collection	pounds	50,126
Seeding and sodding	acres	58
Other activities:		
Emergency work:		
Wildlife feeding	man-days	291
Other work (floods, etc.)	do	21,343
Eradication of poisonous or pest plants	acres	1,435
Insect pest control	do	1,012
Preparation and transportation of material	man-days	31,974
Reconnaissance and investigation	do	3,166
Rodent control	acres	18,067
Surveys:		
Grade lines	miles	350
Lineal	do	410
Topographic	acres	13,332
Type	do	32,775
Other	man-days	4,946

COOPERATION OF WORKS PROGRESS ADMINISTRATION

Allotments of $1,628,926 by the W. P. A. enabled the Survey to carry on projects designed to provide employment for those in need of relief and at the same time to conserve water and wildlife, check floods and erosion, increase fur production, provide stable water supplies, and develop waterfowl refuges in the following States: North Dakota, Montana, South Dakota, Nebraska, Louisiana, Oklahoma, Michigan, Wisconsin, and Wyoming. Work was done on such important wildlife-restoration projects as the 75 easement refuges in North Dakota and Montana, the Souris River refuges in North Dakota, the Red Rock Lakes refuge in Montana, the Delta refuge in Louisiana, and the Seney refuge in Michigan.

The Long Lake Migratory Bird Refuge in Burleigh County, N. Dak., one of the easement refuges, exemplifies the type of work thus made possible and the results obtained. Although part of this once excellent waterfowl area was purchased by the Biological Survey in 1932, it was most of the time a dry, barren lake bed until extensive development was undertaken after W. P. A. labor and funds became available. Long Lake is again functioning as a nest-

ing haven for migratory waterfowl. Three large dikes and several smaller ones have been constructed and have caught a large part of the run-off from winter snows and spring rains. For the first time in years this 14,000-acre marsh area was covered with water, and ducks returning from the South last spring settled there by the hundreds. The dikes now provide three water-holding units, two of which are already excellently suited for waterfowl nesting. During dry spells, the spring run-off can be confined to these two units, thus assuring the birds plenty of water at all times. This year, these two units had a depth of 4 feet of water and their overflow filled the remaining unit to a depth of 1½ feet.

If for no other reason than the conservation of water, the W. P. A. projects sponsored by the Biological Survey on its bird refuges in the West are distinctly advantageous to the communities in which they are located and are well worth their cost. In addition, in accomplishing their prime purpose, they are at the same time providing work for the needy and improving wildlife conditions.

On the Delta Migratory Waterfowl Refuge, a 48,735-acre wintering haven for waterfowl in Plaquemines Parish, La., that is also representative of the refuges under development, crews of the W. P. A. have made outstanding progress. Inaccessibility of the area made it necessary to obtain four "quarterboats" from the United States district engineers on which to house the men working on the refuge. Though no development work had been undertaken earlier, a great deal has been accomplished since the advent of the W. P. A. crews in August 1936, including the razing of numerous unserviceable buildings at the old quarantine station, the construction of new ones, and the repair of others from salvaged materials, construction of a sea wall, a wharf, and fences, posting boundaries, and landscaping.

COOPERATION OF NATIONAL YOUTH ADMINISTRATION

Through cooperation of the N. Y. A. several hundred young men on its rolls, and working under its rules and regulations, began this year to receive preliminary training in wildlife management under the direct supervision of the Biological Survey on many of the Bureau's bird refuges. Their duties consist of observing wildlife, making nest and brood studies, planting for food and cover, and doing other types of work for which they are found qualified. All those selected were first interviewed personally by members of the Bureau, and each month all have been furnished printed and mimeographed bulletins, instruction sheets, and other aids. They are required to prepare weekly reports on the area on which they work, the reports are carefully checked, and records are made for future reference. Letters are written as necessary advising of errors in reporting, answering the many inquiries made, and encouraging the writers to continued enthusiasm in their wildlife work,

The training given has been along the lines of conservation, wildlife management, and identification of native plants and animals, and the young men have made great advancement and improvement in the work since its inception in January. Some examples of individual assignments are: Patrol of the refuge areas; submission of weekly reports on the state of structures, signs, buildings, plant and animal life and on water conditions; observing and reporting on the activities of predators; planting tree and shrub seedlings; destroying nests of crows; finding, staking, and watching duck nests; acting as unofficial game warden (reporting violations to the Biological Survey agents in charge of the refuge); and cultivating and caring for plantings made on the refuge.

This cooperative work is mutually beneficial to the Bureau and to the young men: To the Bureau it is valuable not only in the work accomplished, but also from a public-relations standpoint, as the interest and enthusiasm of this group of workers is resulting in a more general interest in and knowledge of wildlife conservation in the communities in which they reside. For the young men thus employed it is providing much-needed work and is giving them training in wildlife-management practices that may be useful in later life.

ENGINEERING WORK ON REFUGES

For the purpose of facilitating the supervision and direction of the engineering work on the Biological Survey's migratory-waterfowl restoration projects, the United States has been divided into three districts—the eastern, central, and western—with an engineer from the Bureau of Agricultural

Engineering in charge of each. The work in all three districts has included surveying, topographic mapping, preparation of plans for the construction of water-control structures, and actual construction work. Among outstanding accomplishments were the completion of a water-control structure on Jack Creek in the Cape Romain Refuge, S. C.; preparing and letting the contract for constructing dikes and control structures on the Mud Lake Refuge, Minn.; surveying the entire Sabine Refuge, La., and preparing plans for the stabilization of the water levels in one unit; completion of the east levee on the Squaw Creek Refuge, Mo., by C. C. C. labor; construction of a dam and control structure on the Talcot Refuge, Minn.; completion of construction of a dike and water-control structures on unit 1 of the Seney Refuge, Mich.; building by C. C. C. forces of dam 357, with control structures, on the Lower Souris Refuge, N. Dak.; and preparation of plans for diverting the Little White River into pools on the Lacreek Refuge, S. Dak.

In addition, topographic surveys and complete engineering plans necessary for letting bids have been made on the Savannah River Refuge, in Georgia and South Carolina; Boulder Canyon Refuge, in Arizona and Nevada; Rice Lake Refuge, Minn., Delta Refuge, La.; Bombay Hook Refuge, Del.; and Mattamuskeet Refuge, N. C. Through a cooperative arrangement with the C. C. C., water-control, conservation, and development works are in process of construction on the Malheur Refuge, Oreg., Tule Lake and Sacramento Refuges, Calif., and Medicine Lake Refuge, Mont.

Other important engineering activities for the year include the filing of water rights on all North Dakota refuges and on the Medicine Lake Refuge, Mont.; release of water from the large storage dam on the Upper Souris Refuge, N. Dak., which was supervised by the Souris River watermaster, a hydraulic engineer employed by the Biological Survey; supervision and distribution of the spring run-off of the Souris River; and completion of an engineering report for the National Resources Committee on the Bosque del Apache Refuge, N. Mex.

Engineering plans were made during the year in a cooperative attempt of the Bureau of Biological Survey and the Utah Fish and Game Commission to eliminate a natural death trap for water birds on Great Salt Lake, at the mouth of the Weber River in Utah. In the past thousands of birds have perished here annually from botulism, a disease that prevails in these alkaline flats during periods of low water. Construction work is already under way through the use of a large C. C. C. detachment from the Bureau's Bear River camp.

HABITAT RECONNAISSANCE AND IMPROVEMENT

Water-impoundment structures erected during the year serve to increase the production of aquatic food plants on many refuges as well as to insure an ample supply of water on nesting areas to accommodate young birds during the flightless stage. To supplement food and cover plantings attractive to birds on refuges that were deficient in this respect, more than 300,000 pounds of seeds, tubers, rootstalks, and other vegetative parts were gathered on other refuges where the stand was ample for the purpose. Much was accomplished also in eradicating certain species that retard or prevent the growth of recognized waterfowl food and cover plants. Noteworthy was an operation at the Mattamuskeet Refuge, N. C., where more than 2,500 acres of dense cattails were cut at the time when the plant's energy was being expended in producing fruiting heads. The few stalks that reappeared were again cut, after which the rootstalks perished. The disappearance of cattails was followed by a dense growth of the highly desirable three-square bulrush.

Practically every refuge has some sections of value to the local upland game birds and mammals. Tracts unsuited to the nesting requirements of waterfowl are utilized for growing food plants for them and for food and cover for upland game. Development of these areas includes the planting of wheat, corn, millet, milo, clover, rye, barley soybeans, alfalfa, and similar crops. Many of the grainfields are harvested to supply seed for future planting and supplementary winter food for the birds.

Approximately 5,500,000 trees and shrubs suitable for food and cover and tolerant of local conditions were planted during the year on refuges in the Great Plains region, where such growth has been destroyed by recent years of drought and overgrazing. About two-thirds of this total was temporarily set out in nurseries and the remainder in their permanent locations according to the improvement plans.

While planting is being undertaken primarily to provide food and cover, every effort is being made to control wind and water erosion by use of appropriate vegetation. Many miles of newly constructed dikes have been sown also to soil- and sand-binding grasses.

The fact that islands are relatively free from predators renders them attractive as resting and nesting sites to many species of water birds. For this reason, in its efforts to improve conditions for wildlife on its refuges, the Bureau has constructed many artificial islands, which not only have attracted migratory waterfowl but also nesting colonies of other species of water birds. Cormorants, pelicans, and ring-billed and California gulls have colonized on several islands on the Bear River Refuge, Utah; pelicans and gulls have bred in large numbers on an island on the Malheur Refuge, Oreg.; and cormorants and terns were noted on the islands of the Waubay Refuge, S. Dak., soon after their completion.

To provide for the needs of the tree-nesting species of waterfowl, including wood ducks and goldeneyes, which find a dearth of suitable cavities in trees, a number of nesting boxes have been constructed and placed on many of the Bureau's refuges. On Waubay Refuge, S. Dak., two of three such boxes were this year occupied by goldeneyes. The fact that only one previous nesting record has been established for this species in South Dakota demonstrates their value.

To prevent interference with the production of waterfowl and other game birds, intensive work was undertaken on many refuges for the control of predators in no immediate danger of extermination. Major activities were against skunks, which were found to destroy 30 percent of the nests on the Lower Souris Refuge in 1936. Other more or less destructive nest robbers are bull snakes, coyotes, foxes, raccoons, and crows.

EASEMENT REFUGES

The phase of the migratory-waterfowl restoration program instituted in North Dakota in 1935 with the establishment of 32 easement refuges was this year extended to Montana. The success of the 1936–37 program, as well as of the first year program, has been primarily due to the splendid cooperation of the various counties and other political subdivisions in lending their facilities and equipment and of landowners and other conservation-minded residents who gratuitously granted perpetual easements to the sites and otherwise lent their support and assistance. As a result of this cooperation there are now 75 easement refuges in these two States, both of which contain important waterfowl breeding grounds. Of the aggregate of the 118,777 acres composing these 75 refuges, rights to 110,154 acres were thus acquired without cost to the Government (table 3).

All development work on these easement projects has been done by W. P. A. relief labor. Of the W. P. A. funds allotted to the Bureau for migratory-waterfowl conservation, a large part was expended on this type of project. Since the cost of procuring the sites was negligible, and since great savings were effected by the use of borrowed equipment, practically all the available funds passed directly into the hands of deserving relief clients.

The new projects added during the year were selected primarily for their value as waterfowl and other wildlife refuges, secondarily as water-conservation projects, and lastly as recreational areas. The availability of relief labor and the need for work projects were also taken into consideration. Every effort was made so to locate the proposed projects with reference to others already established as to avoid a concentration of refuges in any one section of a State.

The heavy rainfall and run-off during the spring of 1937 provided an adequate test for the water-control structures on established easement refuges and demonstrated their worth in water conservation and as waterfowl projects. It was estimated in the fall of 1936 that there were about 2,000,000 birds on the 71 projects in North Dakota.

The extension of the easement-refuge system into Montana did not actually get under way until April 15, and the four projects in that State are still in the construction stage. Some difficulty was experienced in getting started, primarily because the program was entirely new to Montana residents and required some educational work. Further, Montana laws lend themselves less easily to this purpose than those of North Dakota, where the State legislature authorized and directed the several counties in which Biological Survey refuge projects are located to exempt from taxation all inundated refuge lands and to waive recording and filing fees for necessary documents.

TABLE 3.—*Bird refuges established in North Dakota and Montana by gratuitous easements to the Federal Government*

State and refuge	County	Area
North Dakota:		*Acres*
Appert Lake	Emmons	1,120
Ardock Lake	Walsh	[1] 3,025
Billings Lake	Cavalier	760
Bone Hill Creek	LaMoure	640
Buffalo Lake	Pierce	2,073
Camp Lake	McLean	1,313
Canfield Lake	Burleigh	458
Charles Lake	Hettinger	800
Chase Lake	Stutsman	[1] 3,484
Cherry Creek	McKenzie	400
Clearwater	Mountrail	187
Clouds Lake	Sargent	840
Cottonwood Lake	McHenry	1,013
Dakota Lake	Dickey	2,520
Flickertail	Emmons	640
Florence Lake	Burleigh	670
Half-way	Stutsman	160
Hiddenwood	McLean	568
Hobart Lake	Barnes	1,791
Hutchinson	Kidder	458
Johnson Lake	Nelson and Eddy.	1,608
Kellys Slough	Grand Forks	[1] 1,490
Lac aux Mortes	Ramsey	[1] 5,338
Lake Elsie	Richland	645
Lake George	Kidder	3,107
Lake Ilo	Dunn	2,460
Lake Moraine	Burleigh	320
Lake Nettie	McLean	1,800
Lake Oliver	Oliver	640
Lake Patricia	Morton	1,280
Lake Susie	McLean	480
Lake Tewaukan	Sargent	[1] 4,548
Lake Zahl	Williams	3,497
Lambs Lake	Nelson	320
Legion Lake	Mountrail	600
Little Goose	Grand Forks	360
Little Lake	Emmons	480
Long Lake	Burleigh	[1] 18,005
Lords Lake	Bottineau	1,877
North Dakota—Contd.		*Acres*
Lost Lake	McLean	960
Maple River	Dickey	1,120
Minnewastena	Benson	160
Oen Lake	Ward	640
Painted Woods	McLean	957
Pioneer Lake	Walsh	640
Pleasant Lake	Benson	986
Prairie Lake	Nelson	320
Pretty Rock	Grant	800
Rabb Lake	Rolette	262
Rock Lake	Towner	7,840
Rose Lake	Nelson	1,280
School Section Lake	Rolette	680
Shell Lake	Mountrail	1,677
Sheyenne Lake	Sheridan	838
Sibley Lake	Griggs	1,091
Silver Lake	Benson	2,960
Snyder Lake	Towner	992
Springwater Lake	Emmons	640
Stewart Lake	Slope	1,920
Stoney Slough	Barnes	2,000
Storm Lake	Sargent	[1] 682
Sunburst	Emmons	495
Tobacco Garden	McKenzie	120
Tomahawk	Barnes	440
White Lake	Slope	960
Wildfang	Burleigh	560
Wild Rice	Sargent	240
Willow Lake	Rolette	2,836
Wintering Lake	McHenry	400
Wood Lake Marsh	Benson	545
Yanktonai	McLean	800
Montana:		
Black Coulee	Blaine	1,160
Hewitt Lake	Phillips	1,200
Lake Mason	Musselshell	4,200
Thibadeau	Hill	3,601
Total		[1] 118,777

[1] Including acreage acquired by purchase in 7 refuges in North Dakota as follows: Ardock Lake, 291 Chase Lake, 500; Kellys Slough, 690; Lac aux Mortes, 8; Lake Tewaukan, 80; Long Lake, 7,052; and Storm Lake, 2; total, 8,623 acres.

PROVIDING FOR MAINTENANCE AND PATROL

The acquisition of more than 2,000,000 acres of refuge land during the year has resulted in greatly increased responsibility and activity in maintenance and patrol. Practically all waterfowl refuges now containing sufficient acreage for administration have been provided with a skeleton staff of managers and technical assistants. Additional men have been employed for supervision, administration, and patrol, and, in some cases, for suppressing predators. With the constant supervision and guidance of the older, more experienced men, the organization has been maintained on a highly coordinated basis and at a minimum cost.

The increased refuge acreage has also resulted in proportionately increased expenditures for equipment, including fences and engineering and housing structures. The maintenance program has involved construction of several hundred miles of fence; extensive road, trail, fire, and truck-trail building, repair, and rebuilding; and thousands of yards of riprapping and earth moving for the reenforcement and repair of impoundment dikes and levees. Innumerable lesser undertakings have been necessary to maintain all the areas and have them function for wildlife in full measure.

During the past year the Treasury received $31,623 chiefly for haying and grazing leases granted locally in order to provide food and water for livestock and limit the fire hazard created by weed and grass growth. During last summer's severe drought the refuges in the Great Plains region provided the only good forage for the livestock on many neighboring farms. An intensive survey was recently begun on all major refuges to ascertain the acreage

under Bureau jurisdiction that can be safely allotted for such public use under permit, in order to realize a maximum of profit and maintain maximum protection for wildlife.

There has been the usual demand for the emergency feeding of wildfowl and upland game birds during the past winter, and many tons of grain have been used on refuge areas, particularly in northern and mountainous sections. An increasing number of upland game and other birds has been noted as a result of these operations.

ADMINISTRATION OF NATIONAL WILDLIFE REFUGES

At the beginning of the year there were 164 wildlife refuges under the jurisdiction of the Biological Survey, estimated to aggregate 9,943,023 acres. At the close of the year the refuges numbered 231, and the estimated acreage under control or approved for purchase was 11,482,374. Of these refuges 216 are in the United States (7,391,485 acres) and 15 in Alaska, Hawaii, and Puerto Rico (acreage estimated as 4,090,889). These national wildlife refuges may be classified by functions as shown in table 4. In addition the Bureau administers 14 smaller experimental and administrative units (aggregating 9,791 acres) on which wildlife also is protected.

TABLE 4.—*Number and extent of national wildlife refuges administered by the Biological Survey*

Classification	Number	Acres
Migratory-waterfowl refuges	128	1,424,403
Refuges for other migratory birds	54	887,734
Wildlife refuges (birds, mammals, and others)	10	4,040,531
Refuges chiefly for nongame birds	28	111,479
Big-game preserves and ranges	11	5,018,227
Total	231	11,482,374

BIRD REFUGES

WILDLIFE TRENDS ON BIRD REFUGES

The success of the waterfowl-restoration program and the modern game-management practices undertaken by the Biological Survey is already beginning to be manifest in increased wildlife populations on the refuges and their spread over surrounding areas. Species that have not been seen in the vicinity of some refuges for many years are now returning there to breed, to winter, or to rest and feed on their semiannual migrations, sometimes in numbers; and species never before recorded on an area have been noted there within the last few years.

Seven nesting species of birds not previously noted were recorded during the year on the Lower Souris Refuge, N. Dak. These are the Holboell's grebe, great blue heron, greater scaup duck, red-tailed hawk, piping plover, avocet (two were seen in migration in 1936, but they have never before been known to nest here), and common tern. These, together with the 7 additional species recorded for the first time in 1936, make a total of 14 species not recorded as nesting on this refuge before the marsh area was flooded.

No snow or blue geese were noted on the Lower Souris Refuge in 1936, but this year they remained on the area from April 16 to May 18 and reached a peak of approximately 600 birds. The entire diving-duck group showed a decided increase over that of last year; and although the duck migration in general was not so large, the nesting population exceeded that of last year by at least 100 percent.

On the Upper Souris Refuge, N. Dak., some 70 miles upstream from the Lower Souris, the avocet and western grebe nested this year for the first time of record.

The comparatively small-sized Sand Lake Refuge, S. Dak., is proving an outstanding sanctuary for Franklin's gull; and although it is somewhat early at this time to make any definite statement as to the number of these birds using the refuge, it is expected that with the beginning of the harvest season, which

always attracts them by thousands, their numbers will exceed the total of 85,000 present in August 1936. This increase in the number of Franklin's gulls on the Sand Lake Refuge is particularly welcomed by the farmers in the vicinity, since the species is a well-known destroyer of grasshoppers, cutworms, grubs, field mice, crickets, and other plant pests. Several hundred grasshoppers may be consumed in 1 day by a single gull.

Canvasbacks were present in greatly increased numbers on the Bear River Refuge, Utah, during the fall migration. Old-time guides and hunters in the vicinity commented on the fact that they had never before witnessed such a heavy migration of these ducks. Redheads also were unusually abundant but not to the same degree as the canvasbacks.

Shovelers nested this year on the Bombay Hook Refuge, Del., for the first time on record. Fourteen pairs were observed, and eight broods of four to eight each were noted.

On the 4,406-acre Chautauqua Refuge, Ill., it is estimated that there was an increase of 60 percent in the number of visiting ducks during their northward migration over the number present in the same period last year. At the peak of the fall migration more than 400,000 ducks and geese visited the refuge at one time.

A brood of seven young canvasbacks was observed on the P Ranch of the great Malheur Refuge, Oreg.—the first nesting record of this species on the refuge or in its vicinity.

Three species of birds—the common loon, black duck, and cinnamon teal—this year for the first time visited the Crescent Lake Refuge, Nebr., and one nest of the cinnamon teal was discovered. A few pairs of this species were reported to have nested near Whitman, Nebr., as late as 1921, but this is the first definite nesting record in the State for many years. It is also worthy of note that an increase of more than 80 percent in the nesting waterfowl population over that for a similar period last year is reported for this refuge.

Perhaps the most gratifying feature of the year's wildlife recovery is the increase noted in the population of the rare trumpeter swan, which has been restricted to a fraction of its former range and still persists in the United States only on the Red Rock Lakes Refuge, Mont., in Yellowstone Park, and on a few adjacent lakes. Last year's count showed a total of 115 in all these areas, while this year the total was 158, an increase of 43. Ninety of these (39 adult birds and 51 cygnets) were within the boundaries of the refuge. This increase encourages the belief that the Bureau's intensive program of protection, predator control, and nesting-site construction will eventually bring this beautiful bird back from the brink of extinction.

It is impracticable here to report on all the bird refuges administered by the Biological Survey, but a few of the more important details regarding refuges, chosen to represent the various types (that is, breeding, resting and feeding, and wintering) and every major flight lane in the United States, will serve to illustrate the conservation and restoration being accomplished by the refuge system, including necessary technical developments.

TULE LAKE REFUGE

The Tule Lake Migratory Waterfowl Refuge, Calif., containing 36,563 acres of the best resting and feeding grounds for ducks and geese in the Pacific Northwest, attracts countless numbers of migratory waterfowl and other birds each spring and fall and many breeding pairs in summer. More than 800,000 waterfowl concentrated on the refuge in November, including 290,000 pintails, 130,000 mallards, and 60,000 redheads.

During the waterfowl- and pheasant-shooting season, hunting was permitted on part of this refuge, and each hunter was required to register and have his equipment checked before entering and to have his bag examined before leaving. This was effective in keeping violations at a minimum and in permitting an accurate count of the birds killed. During the open seasons the 7,035 hunters admitted to the refuge killed 20,811 birds, an average of 2.9 each, including 10,311 ducks (5,429 of them pintails), 9,919 geese (4,239 cackling and 3,459 white-fronted geese), and 441 pheasants.

Most of the development work on this refuge has been done by the C. C. C. camp stationed for nearly 2 years on the nearby Clear Lake Refuge. Last October, however, a detachment was allotted from the Bureau of Reclamation camp. Accomplishments of these two camps included the construction of 3 overnight cabins, a garage (with storeroom and fuel space), a large head-

quarters building, an equipment shed, 2 sewage-disposal tanks, and a lookout tower; the erection of 66 miles of fencing and boundary marking; construction of a dike and other water-control structures, 28 nesting islands, 46 quail shelters, a telephone line, and 10 miles of truck trails; regrading 5 miles of truck trails and surfacing with gravel; general clean-up work on 213 acres and landscaping of 5 acres at the headquarters; collecting 1,255 pounds of seed and 20,000 pounds of rootstocks of aquatic plants; planting 150 acres with food and cover plants; and developing a nursery (including the setting out of 50,000 trees).

RED ROCK LAKES REFUGE

The Red Rock Lakes Migratory Waterfowl Refuge, Mont., now containing 26,138 acres, is an area of great scenic beauty high in the Rocky Mountain section of Montana that separates Idaho and Wyoming, approximately 30 miles west of Yellowstone National Park. The efforts of the Biological Survey to preserve and increase the numbers of the rare trumpeter swan, which now makes its home on this refuge and on a few lakes in Yellowstone Park, are meeting with success. During the summer of 1936, a total of 31 swans and 26 cygnets were recorded on and near the refuge, an increase of 10 over the number counted the previous year. A survey made this year in conjunction with the National Park Service shows an even greater increase, the figures being as follows (cygnets shown in parentheses): Yellowstone Park, 38 (26); adjacent to Yellowstone Park, 4 (0); Red Rock Lakes Refuge, 34 (51); adjacent to Red Rock Lakes Refuge, 5 (0); total, 81 adults, and 77 cygnets. Thus there are 33 more of these swans on and near the Red Rock Lakes Refuge than in the similar period of 1936. Unlike other species of waterfowl the swans remaining do not migrate. Each winter between 40 and 50 stay in the small open spring heads at the east end of the refuge, where they are protected from man and predatory animals. Here also they are fed if the winter proves to be unusually severe and natural foods are scarce. During the past winter about 20,000 pounds of grain was supplied, but some of it was eaten by other species wintering there.

Seventeen species of ducks now nest on the refuge, and it is estimated that 20,000 to 30,000 were produced there this year. At the end of June approximately 150,000 concentrated on the refuge and remained there through the molting period. The first nesting record of the avocet for the refuge was established this year, when two pairs raised young.

Approximately 33 percent of the refuge was opened to hunting last fall, when 71 hunters bagged 776 ducks. During this period, the trumpeter swans voluntarily moved to the upper lake region, where they received absolute protection. The hunters cooperated fully in safeguarding this and other protected species.

A crew of W. P. A. relief workers was assigned to this refuge in the latter part of May to do fencing, posting, dam rebuilding, and construction work on headquarters buildings, bridges, roads, trails, and a telephone line.

LOWER SOURIS REFUGE

The 58,302-acre Lower Souris Migratory Waterfowl Refuge, N. Dak., is one of the most important of those recently established by the Biological Survey. At different times during the year 196 species of birds were observed there, 10 more than last year. The number of nesting species was increased by 7, which, in addition to the 7 new records for the refuge last year, brings the total nesting species to 101.

Great increases have been noted in the population of several other species of wildlife on the refuge, including sharp-tailed grouse, prairie chickens, Hungarian partridges, deer, and foxes. The foxes have now reached the point where they are objectionable as predators on nesting ducks.

Nesting studies have revealed that whereas in 1936 there was a 54.4-percent hatch of ducks on the refuge, with a 30.4 percent nest destruction by skunks, this year it is estimated that there will be about a 70-percent hatch, with less than 7 percent similar destruction. This great decrease in the loss of nests is due to extensive predator control carried on since November 1—423 skunks alone having been taken, as well as 146 weasels, 41 house cats, 20 minks, and 9 coyotes.

Since October 1, W. P. A. labor has supplemented the work of the C. C. C. camp, and accomplishments of the two have included the planting of food crops on 403 acres and 252,335 trees; partial construction of a large dam across the valley near the refuge boundary, and completion of 2 rubble-masonry plug

dams in the river channel; building 10 miles of truck trails and 80 miles of boundary fence, the latter chiefly by W. P. A. labor; the razing of 44 undesirable structures; and general clean-up work, besides recreational area development and sign and marker construction.

MALHEUR REFUGE

The 159,966-acre Malheur Migratory Bird Refuge, Oreg., has revealed unquestionable evidence that the present program for the conservation of the country's wildlife resources is not in vain. Far greater numbers of migratory waterfowl flocked there during the past fall and spring than in corresponding periods in the previous year. The winter-resident waterfowl population was small, for with the water frozen over, temperatures hovering between 0° and —42° F. for more than a month, and the ground covered in many places with deep snow, it was almost impossible for the usual waterfowl population to remain.

The creation of lagoons, ponds, dikes, and canals over the refuge seems to have been an incentive for waterfowl to nest in practically all the meadows and formerly dry fields, to a greater extent than in any previous season within the drought cycle. The canvasback duck was found nesting on the refuge for the first time, and there was an unusually successful hatch of Canada geese. Among other breeding species were the sandhill crane, American egret, long-billed curlew, willet, Wilson's snipe, phalaropes, gulls, terns, grebes, and herons.

The Malheur Refuge is proving a distinct asset to the surrounding community, from its value not only for wildlife production but also for recreation and for regulated haying and grazing. Although relatively few campers visited the refuge this year it was much used by fishermen and picnickers. To encourage and specialize on this type of use, a campground with ample camping facilities is being provided.

Somewhat more than 30,000 animal-months' use for grazing was made of the refuge during the 1936–37 season, and approximately 6,000 tons of hay were cut. In addition herbage on several hundred acres of meadows was mowed and bunched for the use of livestock, and 6,000 bushels of grain were threshed by permittees from about 90 acres of bottom land. Later the grain stubble provided an excellent winter feeding place for geese, ducks, and sandhill cranes.

Two C. C. C. camps stationed on the refuge the entire year and a third established on April 1 made many and varied improvements. The headquarters building group, consisting of an office, residences for the superintendent and a clerk, a service building, a barn, and a pumphouse, was completed; another residence was built and the renovation of the old P Ranch buildings was nearly completed. Other accomplishments included the construction of a lookout tower, 20 bridges, a concrete diversion dam, 95 miles of fencing, 35 miles of telephone lines, 58 miles of truck trails, 12 cattle guards, and 2 reservoirs, besides landscaping, razing undesirable structures, general clean-up work, and marking 116 miles of boundary.

CAPE ROMAIN REFUGE

The vast marshes of the 59,921-acre Cape Romain Migratory Bird Refuge, S. C., are giving sanctuary to numerous waterfowl, shore birds, nongame birds, and mammals. With food conditions especially good, about 50,000 ducks, chiefly black ducks, mallards, and wigeons, wintered on the refuge, and pintails were for the first time present in numbers. Rails, which are heavily shot in the vicinity, find sanctuary on the refuge, and nest in the marshes by thousands. Numerous nests of the loggerhead sea turtle were observed along the beaches. Bird Island in the Bull Bay section, which was once washed away, is again building up and is being much used by shore birds. On another small bird key the nesting of a new colony of approximately 5,000 royal terns was outstandingly successful.

Landscaping the headquarters site, which was completed during the year with the aid of C. C. C. personnel from a nearby national-forest camp, included making more than 5,000 cubic yards of earth fill, building concrete steps and walks, and gathering and distributing 6,000 bushels of shells on parking areas and driveways. In addition half a mile of fence was constructed and 2,000 bushels of oystershells were placed along the west side to prevent washing by waves. One tower was painted.

During the past few years the beach on the northeast part of Bull Island has been greatly eroded, but this year jetties were constructed by the C. C. C.

personnel, under the supervision of an experienced engineer . These turned the tide toward building up the beach at a most encouraging rate. The C. C. C. forces have also been engaged in building up to grade a dike that will impound a large pond of fresh water. That this pond will successfully maintain itself by natural rainfall has been evidenced by the fact that it has filled up three times after being drained because of construction necessities. In addition the C. C. C. crew has completed a boathouse and wharf at the Bull Island landing, a dock, garage, and storage building at the landing on the mainland, and considerable work on fire lanes and trails.

BEAR RIVER REFUGE

The Bear River Migratory Bird Refuge, Utah, an area of 51,835 acres, is outstanding in the number of birds it produces annually and in the number and variety of other forms of wildlife it protects. There was a marked increase this year in the number of waterfowl frequenting the refuge, and at the peak of migration in September it was estimated that 1,200,000 ducks and geese were concentrated there. Particularly interesting was the increase in the number of canvasbacks, which were present last fall in greater numbers than ever before. Early in December 12,000 whistling swans were on the refuge. With food conditions good, a large number of the birds remained until the complete freeze-up early in January. Three new bird visitors appeared during the spring migration—blue goose, least bittern, and herring gull—bringing to 199 the number of species recorded for the refuge. More birds nested on the refuge than in any previous year since its establishment, and to ascertain their numbers an intensive nesting survey was begun at the end of the year.

In November the 1,316 hunters who registered at the refuge headquarters to hunt on the section open to public shooting took a total of 5,488 ducks and geese of all species, or an average bag of 4.17. Since census records kept for the refuge show that there were approximately half a million ducks and geese there during that month, the kill was only slightly higher than 1 percent. There were few violations of the regulations, and these were of a minor nature. Approximately 2,615 people interested in wildlife conservation visited the refuge in the 3 months April to June.

A zealous attempt was made during the year to gather and care for all birds showing symptoms of botulism (western duck sickness). Daily trips were made over the dikes and into infected parts of the marsh, and sick birds were collected in crates and taken to the "duck hospital," where a total of 6,094 ducks of nine species were treated, of which 3,453, or about 57 percent, recovered. In addition 410 miscellaneous ducks and shore birds were similarly treated.

Improvement and development work undertaken during the year by the C. C. C. camp included maintenance of 37 miles of truck trails and 15,277 square yards of beach line, excavation of earth from channels to permit flooding and to create additional nesting areas, completing a concrete water-control structure, planting 703 small trees and shrubs and collecting 7,000 pounds of seeds, building a garage, a barge, and a sewer line and disposal field, moving 71,255 cubic yards of earth in the construction of dikes, and graveling the parking area, besides doing additional work on the laboratory and duck hospital, on lake and pond development, and on posting 16 miles of boundary.

WHITE RIVER REFUGE

Because of its great winter concentrations of birds, the White River Migratory Waterfowl Refuge, Ark., now containing 100,706 acres, is one of the Biological Survey's major refuges. During the latter part of October, mallards, gadwalls, baldpates, green-winged teals, shovelers, and many other species of waterfowl began to appear, and in January, it was estimated that fully 700,000 ducks were wintering there. Coots and many of the shore birds also were observed during the migration periods, double-crested cormorants were present spring and fall, and anhingas were common in summer, as also were American and snowy egrets, wood ibises, little blue herons, and green herons, and great blue herons remained all through the year. White-tailed deer were numerous, as were swamp rabbits, fox squirrels, gray squirrels, minks, raccoons, and otters.

At the beginning of the year there were two C. C. C. camps on the refuge, and in December another camp arrived for construction work on dams, dikes, and levees; clearing areas to be flooded for planting to aquatic vegetation; constructing trails (38 miles) and fire lanes; building six bridges, a head-

quarters equipment building, and three lookout towers; and improving wildlife habitat, fencing, and posting.

Thirteen violators of State game laws apprehended during the year paid fines ranging from $10 to $50. During the winter floods of the Ohio and Mississippi and their tributaries, considerable rescue work was done by refuge employees and members of the C. C. C. camps. Using their own motorboats as well as tugboats, barges, and trucks, the C. C. C. boys transported hundreds of refugees to places of safety, and on February 3 one of the camps cooked the meals for 125 refugees near St. Charles.

UPPER MISSISSIPPI RIVER REFUGE

The Upper Mississippi River Wildlife and Fish Refuge, extending for 284 miles along the upper Mississippi through four States from Rock Island, Ill., to Wabasha, Minn., now contains 149,543 acres, and with the steady progress being made toward the completion of the 9-foot channel canalization program, it is estimated that the War Department has or will acquire within the authorized limits of the refuge an additional 64,862 acres. This will be available for administration as a part of the refuge, and a further area of 9,716 acres has been or will be acquired by flowage easements.

Development work completed during the year included the posting of approximately 120 miles of exterior boundary (mostly by W. P. A. labor), and the completion of a storage warehouse, garage, and marine railway at Winona, Minn. During the period March 1 to April 15, 253 persons were authorized to trap on a small part of the refuge, and an average of about 36 muskrats was taken by each permittee. There was an increase of about 20 percent in the number of waterfowl hunters on sections opened to shooting during the fall season. Sixty-eight violators of various regulations were apprehended during the year.

UPPER SOURIS REFUGE

The Upper Souris Migratory Waterfowl Refuge, N. Dak., comprising 30,958 acres, some 70 miles upstream from the Lower Souris Refuge, provided nesting sites for 12 species of waterfowl, and the avocet and western grebe were recorded as nesting there for the first time. In all, 58 species of birds were reported on the refuge during the year. Most of the artificial nesting islands were entirely covered with the nests of terns, avocets, killdeers, and other shore birds, especially the parts that had been graveled, but the many upland game shelters were not used so much as had been anticipated, possibly because the winter was mild; they were frequented to some extent, however, by Hungarian partridges, sharp-tailed grouse, and ring-necked pheasants.

A park and recreational area being provided just below the large storage reservoir constructed last year, known as Lake Darling, is already much used by outdoor enthusiasts, especially on Sundays. The water seems to be the main attraction here, as the supply had been scanty during recent drought years.

The work of two C. C. C. camps has included construction of telephone lines, dikes, truck trails, and artificial nesting islands, landscaping, riprapping, seed collection, recreational development, posting (the refuge was completely posted during the year), remodeling of headquarters buildings, and fencing (87½ miles were completed).

A crew of W. P. A. workers, assigned to the refuge on November 15, 1936, razed undesirable buildings, cleared land, and constructed duck islands, fish shelters, upland bird shelters, and, in conjunction with the C. C. C. camps, a water-gaging station.

SENEY REFUGE

The Seney Migratory Waterfowl Refuge of 74,550 acres, in Michigan, always attractive to wildlife, drew larger numbers than ever this year. Important species of waterfowl nested in more or less abundance on the refuge, several—the baldpate, pintail, green-winged teal, and ring-necked duck—for the first time of record, and others, as well as upland game birds and numerous shore birds were present during the spring migration. Other first-nesting records on the refuge were of the pied-billed grebe (100 pairs), horned grebe, eastern least bittern (27 nests in two colonies), and American coot (at least 15 pairs). A total of 170 species were observed as migrants, breeding residents, or winter residents.

The C. C. C. camp completed the dike and water-control structures on unit 1, a fire tower, spillway, and entrance gates, and a public shelter and double fireplace; and remodeled the refuge residence and redecorated all refuge buildings. Other accomplishments were in landscaping, seeding 14 miles of dikes, constructing 7 miles of barbwire fence and 7 miles of telephone line, creosoting 2,134 fence posts, and planting 9,890 willow shoots. In July and August the enrollees expended 4,150 man-days in fire suppression on and near the refuge.

Approximately 3,000 persons interested in wildlife conservation visited the refuge headquarters during the year. Under permit, 600 man-days were spent in berry picking, 1,894 man-days in deer hunting on the western half of the refuge in November, and 600 man-days in grouse and prairie chicken shooting. The hunting took place on lands on which options have been taken but to which title had not yet been transferred.

VALENTINE REFUGE

On the Valentine Migratory Waterfowl Refuge, now consisting of 68,032 acres situated in the heart of the Nebraska sand hills and including such well-known and important waterfowl lakes as Dewey, Pelican, Hackberry, Dads, Marsh, and Whitewater, the C. C. C. camp has done much to improve the already good waterfowl conditions. Their accomplishments, supplemented by those of a crew of W. P. A. laborers, which began work in August, include construction of 81½ miles of boundary fence, landscaping and completion of the refuge headquarters buildings (consisting of a residence, administration building, service building, tuber cellar, and bird hospital) at Hackberry Lake, trail and road improvement, relocation of the recreational resort, which included the moving of 14 cabins and the digging of 3 wells, placing 15 miles of telephone posts, constructing 200 miles of fire lanes, building 1 peninsula and several pot holes for the birds, completing work on diversion ditches, and planting seeds, tubers, trees, and shrubs (including the planting of 1,352,000 lining-out stock in the nurseries).

Continued research on the refuge by advanced students of the Division of Conservation and Survey of the University of Nebraska included a survey of the aquatic invertebrates in all the lakes, cover mapping, and a study of algae. Duck-nesting surveys show a fivefold increase over the 1936 season, the most abundant breeders being pintails, mallards, blue-winged teals, canvasbacks, redheads, ruddy ducks, and gadwalls. Other birds that nested in abundance on the refuge were curlews, avocets, upland plovers, western willets, black terns, coots, rails, gallinules, grouse, and pheasants.

MATTAMUSKEET REFUGE

One of the most important goose and swan wintering areas on the Atlantic coast, the 50,466-acre Mattamuskeet Migratory Waterfowl Refuge, N. C., which is on the site of an unsuccessful drainage project, is each year giving more tangible evidence of its value for wildlife. In midwinter it harbored 48,000 Canada geese, about an equal number of ducks of various species, and 15,000 whistling swans, a tremendous increase over the previous year. Approximately 42,000 of the ducks were pintails, and although the refuge is not primarily a nesting area, numerous wood ducks and a few mallards nested there.

Fishing and hunting permits were issued by the State of North Carolina under Bureau supervision to 3,472 fishermen and to 898 waterfowl hunters. Local hunting rules were changed this year to require that an authorized guide be in constant touch with each hunting party, thus minimizing the danger to protected species of birds. In addition to hunters and fishermen, many nature lovers and bird students now visit the refuge.

The C. C. C. camp has made the refuge more attractive to wildlife and facilitated administration. Work accomplished included completion of the administration building and an apartment for the refuge manager, construction of a lookout tower and an all-metal garage, remodeling of an old metal building into a supply house and of a small brick building, which once served as a post office, into a power distribution and oil house, road maintenance and improvement, completion of 27 miles of fencing and boundary marking, and the digging of a 3-mile diversion canal to safeguard cultivated areas. Diligent patrol resulted in the apprehension of eight violators of refuge regulations.

SAND LAKE REFUGE

During the hot, dry summer of 1936, water levels of the lakes within the Sand Lake Migratory Waterfowl Refuge, S. Dak., now consisting of 19,733 acres, reached an all-time low. Conditions were inviting for the influx of birds during the spring migration and the summer nesting season, even though low water in 1936 had reduced aquatic food plants and cover on areas otherwise suitable for ducklings. During the spring migration 159 species of birds were noted, and in May the number of birds on the refuge was more than six times as great as in the same month last year.

There were 6,000 nests of the economically valuable Franklin's gull on the refuge in June of this year, and during the entire summer of 1936 this species found the refuge an ideal resting place, its numbers increasing steadily until on August 21 they reached about 85,000.

C. C. C. camp accomplishments included construction of an eight-stall equipment shed at the headquarters site, an eight-tank aquatic storage cellar, and a camp shop (from salvaged material); remodeling of the C. C. C. carpentry shop and 2 residence buildings acquired with the refuge; building 66 dams, 14 artificial nesting islands, with a total length of over 10,000 feet, and 51 shelters.

In the summer of 1936, 80 acres along the shores of the lakes were planted to aquatic vegetation, and in the spring the Shelterbelt Division of the Forest Service gave the refuge 1,400,000 lining-out stock, all of which was set out in the nursery, which was enlarged to 22 acres. In addition 836 acres were planted in grain crops, consisting of corn, wheat, barley, oats, rye, and millet.

BIG-GAME PRESERVES

The program for the establishment of big-game preserves in conjunction with the organization of grazing districts under the Taylor Grazing Act of 1934 resulted in the establishment of two large refuges during the year. The Fort Peck Game Range, Mont., comprising 970,000 acres, was set aside by Executive order of December 11, 1936, and the Hart Mountain Antelope Refuge, Oreg., of 215,516 acres, by Executive order of December 21, 1936. The latter is primarily for antelope and sage grouse, although it harbors also substantial numbers of mule deer. The Nevada section of the antelope range, originally defined in the Executive order of September 6, 1935, was continued in a separate unit as the Charles Sheldon Antelope Range under joint administration of the Departments of the Interior and Agriculture with a slight modification in the provisions of the order, by which greater protection will be afforded the antelope, mule deer, and sage grouse. Progress was made also in pending negotiations for the establishment of upland game refuges on several resettlement areas, although none have actually been so designated.

The total number of big-game animals on fenced preserves administered by the Bureau was 2,359 at the close of the year, as compared with 2,356 a year ago (table 5). Reduced forage caused by severe drought in some sections made it necessary to continue heavy disposals of surplus animals to prevent overgrazing and excessive costs for winter feeding.

NATIONAL BISON RANGE

The big-game animals on the National Bison Range, Mont., came through an unusually severe winter but showed some loss of flesh. During the spring and early summer 65 buffalo calves were born, and by the end of June, 15 elk calves, 8 bighorn lambs, and several deer fawns had been seen. One hundred and eleven surplus buffalo were disposed of, 81 by donation to Indians of the Flathead and Blackfeet Agencies for use as food. The few beavers in the northern part of the range along Mission Creek have decreased in numbers, partly from having reduced their food supply of deciduous trees and partly from being trapped outside the refuge when moving up and down the creek in search of new dam sites. About 10,000 ducks wintered on Mission Creek, and a considerable number nested there. During the winter 6,000 ducks were fed about 6½ tons of grain by employees of the Bison Range, at Warm Springs, 3 miles west of the range. At times to reach the feeding grounds it was necessary to plow a road through deep snow all the way from the headquarters. The ducks came through the winter with slight losses, only about a dozen having been found dead. Pheasants, which are comparatively numerous, also were fed during severe weather. Predatory animals seem to be under control.

TABLE 5.—*Animals on fenced big-game preserves maintained by the Bureau of Biological Survey*[1]

Preserve	Buffalo	Elk	Antelope	Bighorn (mountain sheep)	Deer		Total[2]	Young born in calendar year 1936[3]		
					White-tailed	Mule		Buffalo	Antelope	Bighorn (mountain sheep)
National Bison Range, Mont.	440	[4] 134	------	41	[4] 52	[4] 160	827	80	------	12
Fort Niobrara Game Preserve, Nebr.[5]	140	[4] 35	------	--------	7	2	184	26	1	--------
Sullys Hill Game Preserve, N. Dak.	23	[4] 39	------	--------	11	------	73	7	------	--------
Wichita Mountains Wildlife Refuge, Okla.[5]	344	[4] 241	4	--------	[4] 686	------	1,275	87	------	--------
Total	947	[4] 449	4	41	[4] 756	[4] 162	2,359	200	1	12

[1] With the exception of those of young born, figures are for June 30, 1937.
[2] Including estimates.
[3] Young of elk and deer omitted, as in most cases only estimates could be made, but during the calendar year approximately 79 elk calves, 60 fawns of mule deer, and 74 of white-tailed deer were counted on the preserves.
[4] Estimated.
[5] There are also 123 Texas longhorns on the Wichita Mountains refuge and 10 on the Fort Niobrara preserve, including 25 calves of 1937, 4 of which are in the herd at Fort Niobrara.

The summer of 1936 is reported to have been the hottest for 50 years in that part of the country, and with less than half an inch of rainfall the forage dwindled until the arrival of snow and rains in October. Late disappearance of winter snows had been beneficial to the forage, and the grass made excellent growth until injured by the hot and dry weather later in the season and by grasshoppers, which appeared in the higher parts of the range in vast numbers.

Improvements accomplished by the aid of a C. C. C. camp included needed additions to existing structures, painting all the buildings, erection of two garages and stone portals at the main entrance, considerable revegetation of the range, construction of truck trails, reduction of fire hazards, control of rodents, and eradication of noxious weeds.

With P. W. A. funds an 80-acre exhibition pasture was constructed near headquarters for big-game animals, which can be seen there by the increasing numbers of visitors, for whom a camp has been constructed. A great attraction for them has been a second albino buffalo calf, born in the herd in May. The visitors totaled 1,743 during the year, and the number of automobiles has averaged 15 to 20 on Sundays, and often half that number on other days, some coming from the Atlantic seaboard and the far south.

ELK REFUGE

Up to last year the ever-pressing problem in caring for the elk that winter on the Elk Refuge, Wyo., had to do with providing ample forage. Recent allotments under a special appropriation for refuge acquisition, however, have made it possible to purchase additional lands. This project is now well under way, and its completion, together with that of certain necessary improvements, will solve the former problem. Herd management will also be greatly facilitated by the elimination of livestock grazing and the erection of a drift fence. The fence will prevent the animals from trespassing on adjacent privately owned ranches, where in the past they have destroyed much feed intended for domestic stock.

There is now, for the first time, surplus hay in stacks at the refuge. This condition resulted partly from the kill by hunters of about 6,000 animals in the herd that winters there and partly from an increase in the available hay and in the former grazing range of the elk, through acquisitions that increased the refuge acreage. The State lessened restrictions on hunting in order to reduce the herd to optimum numbers, as it had increased to 22,000. The hay harvested on the refuge in 1936 totaled 2,523 tons, which, with a carryover of 2,173 tons from 1935, besides an available stock of 228 tons of cottonseed cake,

will suffice for any emergency that may arise next winter and permit the sale of surplus hay before its quality deteriorates.

The present surplus of hay is also partly attributable to the fact that the open fall of 1936 delayed the movement of the elk from the mountains. A December snowfall—of 20 inches in the hills, with only 6 inches on the refuge—started the movement, and on December 20 large numbers of elk began to arrive for their winter's stay on the refuge. The maximum number of elk fed during the season was 4,000, and the State game department fed about 800 on the four feeding grounds it maintains. The elk herd survived the winter in good condition, and only 25 of the animals died on the refuge.

Among other forms of wildlife on the elk refuge were Canada geese, 304 of which were counted at one time last fall, and approximately 1,000 ducks, mostly mallards, which remained until about the 1st of December. About 30 sage grouse were on the refuge during the hay harvest last summer, and a few were again seen in the spring. In September one flock of 21 long-billed curlews was noted, thus far the largest number of that species seen on the refuge at one time. Deer have greatly increased in the section during the last few years, a few wintered on the refuge, and 21 came there in the spring and remained for some time. Thirteen bighorn sheep wintered on an adjacent area, and several moose and two bears have been seen on the refuge.

Improvement work during the year included the erection of a 5½-mile woven-wire drift fence, 6 miles of buck and pole fencing, hay sheds (two completed and eight others in course of construction), and other service buildings, and necessary repairs on a dwelling house to provide quarters for an employee on one of the newly acquired tracts.

FORT NIOBRARA GAME PRESERVE

The buffalo and elk on the Fort Niobrara Game Preserve, Nebr., are in good condition, but all the young mule deer received from the Custer State Game Preserve, S. Dak., in 1936, were lost and the antelope fawns obtained in the spring and early summer of 1936 either died from disease or were killed by coyotes, despite every effort to safeguard and raise them to maturity. The coyotes destroyed not only a number of young but also the older antelope kept in a small exhibition pasture. Plans are being made to introduce additional young antelope in the hope that the species can be established here.

Two white-tailed deer fawns were obtained from the Custer Preserve last spring. The Texas longhorns brought from the Wichita Mountains Wildlife Refuge, Okla., in 1936, have become accustomed to their new home, withstood the rigorous winter, and are in excellent condition. The bull and the steer in this small herd have made splendid growth since their transfer, each of the four heifers gave birth to a sturdy calf, and the young animals are growing rapidly. Surplus animals disposed of during the year included 25 buffalo and 12 elk, of which 9 buffalo and 8 elk were donated to the Rosebud Indian Agency, S. Dak., for use as food.

The control of predatory animals constitutes the greatest problem on this preserve, to which they are attracted from the surrounding country by the more abundant food. The protection afforded on the preserve has attracted many fur-bearing animals from outside, and these have greatly increased in numbers under the sanctuary conditions. Especially numerous are skunks and raccoons, though minks and weasels are there in considerable numbers and muskrats have again become plentiful on the ponds.

Ducks, herons, bitterns, rails, and other migratory birds flocked onto the water areas of the preserve last September to obtain the food grown during the summer, and approximately 150 mallards were fed grain during the most severe weather last winter. There were not so many ducks on the preserve, however, as in the previous winter, but more species were represented. Great horned owls were abundant, and eagles wintered on the preserve but did little damage to the ducks, as they fed mainly on rabbits. No quail were seen during the spring, but two large flocks of young pheasants were noted. A few prairie chickens and grouse nested on the area.

There was very little moisture during the winter to relieve drought conditions following an extremely dry fall, and only sufficient spring precipitation to keep the grass alive. Slight grass growth and no seed production was recorded, but on the flat parts of pastures there was a heavy growth of weeds. Grazing conditions were therefore below normal, and as a result of

forage scarcity it will again be necessary to feed hay to the game animals next winter.

The construction by E. C. W. workers of a bridge over the Niobrara River to connect the two big-game pastures was the most important improvement on the preserve during the year. A 125-foot lookout tower was completed at headquarters, and a museum was finished in which there is a creditable display of specimens of mammals, birds, reptiles, and insects found on the preserve and an excellent collection of fossils of the prehistoric mammals that formerly ranged on this area. Other accomplishments with labor provided under the E. C. W. program included improvement of the water-supply system, installation of underground and other power lines, betterment of truck trails and fences, and additional road work. A small detachment of W. P. A. workers was employed during part of the year to complete work begun under the E. C. W. program; also to build a bridge over a small creek, install an irrigation system at headquarters, construct check dams on the preserve, provide living quarters for an assistant, and to do miscellaneous work in landscaping, transplanting trees, and planting for food and cover for wildlife.

SULLYS HILL GAME PRESERVE

Buffalo and elk are thriving on Sullys Hill Game Preserve, N. Dak., and under the surplus-disposal program, three buffalo and one elk were removed, the elk having been donated to a State park for exhibition purposes. Four deer died from a lung disease, and one from an injury. Beavers introduced in October 1935 are building dams, but it is not known whether they have increased.

About 60 acres of lake-bottom land were sown to tame hay, and from it about 50 tons of good forage were harvested and stacked during the summer of 1936. At the end of the fiscal year about 20 tons of hay had been stacked, with more to be put up later. It has not been necessary to purchase hay for the animals for several years.

Improvements, chiefly with W. P. A. labor, included construction in the buffalo and elk pasture of about 5 miles of road, most of which was graveled, fencing off a swampy corner of the deer pasture, building some small dams, placing a cattle guard at the front entrance, and completing a shop building.

The attractive recreational facilities available and the educational opportunities afforded in observing wildlife brought 17,621 visitors to the preserve during the year.

WICHITA MOUNTAINS WILDLIFE REFUGE

Fall rains in 1936 and nearly normal precipitation in 1937 counteracted a searing drought and greatly improved conditions on the Wichita Mountains Wildlife Refuge, Okla. Prospects for a fine mast crop were excellent, with acorns, pecans, and walnuts especially abundant, but browse and other range forage remained below par as a result of drought and some overgrazing by domestic stock.

Buffalo, elk, and Texas longhorns did well in the fenced pastures, and the calf crops were good, though not so large as in 1936. The large herd of buffalo cows and calves, sometimes more than 200 in a single band, could be seen from the main highway by the many thousands of visitors. During the year 37 buffalo, 14 elk, and 18 longhorn cattle, mostly culls and undesirables in the herd, were disposed of, and 10 elk were donated to the State Game and Fish Commission of Oklahoma to restock an area in McCurtain County. Deer have increased both inside and outside the refuge, some estimates placing the number at 3,000, including 680 within the refuge. A pet white-tailed doe that frequented the vicinity of headquarters and is known to have raised 27 fawns in 13 years died, but her descendants now constitute a sizable herd in that locality. Four antelope fawns, captured by refuge employees and several cooperators on the open range in Cimarron County, in the Oklahoma Panhandle, were brought to the refuge in an effort to form the nucleus of a new herd. The fawns are protected from predators in a 7-acre enclosure near headquarters.

A suspension of trapping privileges has resulted in an increase in the numbers of skunks, raccoons, rabbits, opossums, and other fur bearers. A gray fox, a rarity in this section, was captured on the refuge and released after examination. Wild turkeys and bobwhite quail show an encouraging increase, but the num-

bers of prairie chickens remain small. Though food and water were scarce over much of the Southwest it was estimated that during the winter 2,000 ducks occupied the refuge lakes at the height of the season. Crows became so numerous as to necessitate control measures, and 699 of these birds were trapped, as well as 98 coyotes.

Additional fingerlings were added to the lakes during the year by a shipment of about 30,000 from the Bureau of Fisheries station at Tishomingo and by a State donation exceeding that number from the hatchery at Medicine Park. Other game fish were introduced when lakes nearby were apparently drying up and when Lake Thomas was drained for repairs to the dam. Fish planted a year or two years ago are growing well, and the visitors enjoy feeding them from dams and lake shores.

The refuge has been carefully patrolled by the resident staff and by other Bureau employees temporarily detailed for the purpose. Motor-vehicle speeding was quickly curbed as the result of five arrests. A drastic curtailment in domestic-stock grazing will result in increased food and cover and prevent various forms of wildlife from seeking better forage outside, where they would be in danger from poachers. An effective deterrent to deer poaching, prevalent during the winter holiday season, was the arrest of one offender, who was given a 6-month jail sentence.

Increasing public use is being made of the 20,000-acre recreational section, largely by visitors from adjacent parts of Oklahoma and north Texas. Of the more than 325,000 visitors during the year, 40,000 came in 1 day to attend the annual Easter service and pageant conducted by local organizations. Bathing was a major attraction at nine lakes, thousands of picnickers enjoyed the public facilities at seven campgrounds, and outings were held by numerous civic and conservation organizations.

Extensive improvement programs were carried out by two C. C. C. camps and under four W. P. A. projects. The C. C. C. work included completion of a major campground unit (with bathhouses, community house, checking booth, caretaker's cottage, and attendant facilities), a 50-foot high concrete dam, and a group of structures for use in scientific research, as well as scores of smaller projects involving highway and bridge construction, trails, food and cover plantings, landscaping, earth-dam construction, erosion control, and provision of campground facilities.

Work on the Biological Survey's W. P. A. project for the reconstruction of a highway to the summit of Mount Scott is about 70 percent finished, the W. P. A. Easter-pageant development was completed in December, and the construction of a dam, sponsored by the town of Cooperton, was under way as the year closed. At Lake Thomas, which lies partly within the refuge boundaries, W. P. A. crews were engaged in final work on a huge earthern clay-core dam, which will form a lake of approximately 500 acres.

Valuable cooperation in the administration of the refuge was received from authorities at the adjacent Fort Sill Military Reservation and from the Bureau of Animal Industry. A specialist of that Bureau was called upon several times for advice when buffalo developed necrotic stomatitis, and also to inoculate longhorns during an outbreak of pinkeye among cattle grazing under permit.

CHARLES SHELDON ANTELOPE REFUGE AND RANGE

The antelope were late in returning to the summer range on the Charles Sheldon Antelope Refuge, Nev., last spring, but were in good condition when they arrived about the middle of April. There was a good crop of twin fawns, and when they began to follow their mothers late in May the herd made a fine appearance. A Federal trapper on the refuge killed several coyotes during the winter, but with the return of the antelope both coyotes and bobcats have again become overabundant. Mule deer are increasing in number and came through the winter in good shape. Sage grouse also are increasing on all the meadows, though their recovery is slow because of depredations on the young by hawks and owls, which nest on the refuge. Three handsome pinto ponies, a 2-year-old stallion and two brood mares, have been obtained for use in the administration of the refuge and also to perpetuate this breed so largely used as riding stock in the early days of the West. A cold, late spring and lack of spring rains retarded the growth of the grass and dried up all but the permanent springs, but there is apparently ample forage for all wildlife.

During the year E. C. W. workers constructed 10 miles of barbed-wire fence and completed 17 miles of telephone line, an overnight cabin, and work on 9 miles of new and 10 miles of rebuilt roads. Under regular appropriations springs have been developed and a tractor shed completed. For the protection of wildlife the range is regularly patrolled and efforts are made to keep the watering places in sanitary condition and predatory animals under control.

The Charles Sheldon Antelope Range of approximately 542,000 acres in Washoe and Humboldt Counties, Nev., was established by Executive order of December 21, 1936, and is to be administered under the Taylor Grazing Act of 1934 jointly by the Biological Survey and the Grazing Division of the Department of the Interior. It supplements the adjacent Charles Sheldon Antelope Refuge, embracing the winter range of the antelope herd that frequents summer ranges there. It also receives a considerable drift of antelope from the Hart Mountain Antelope Refuge, situated about 20 miles northwest, in Oregon. The Bureau has purchased about 17,000 acres of privately owned lands within the exterior boundaries of the range, primarily for use of the antelope, but has done no improvement work except to repair fences and irrigate the meadows.

HART MOUNTAIN ANTELOPE REFUGE

The Hart Mountain Antelope Refuge, Oreg., and the Charles Sheldon Antelope Range, Nev., contain lands first set apart by Executive order of September 6, 1935, as the Hart Mountain Game Range of 1,024,330 acres. This order was revoked on December 21, 1936, the area in Nevada defined in the original order was reestablished as the Charles Sheldon Antelope Range, and the Hart Mountain Antelope Refuge, with an area of 215,516 acres, was established in Lake County, Oreg. The designation of the Hart Mountain section as a refuge exclusively for the use of the antelope and other wildlife will afford the animals better protection than was provided under the original joint administration for grazing purposes. It will ultimately be enlarged by about 50,000 acres under plans to purchase privately owned lands within its exterior limits.

This refuge includes the fawning grounds and the summer range of the antelope, and to a large extent the winter range as well. With the nearby refuge and range in Nevada it forms a well-rounded project for the conservation and perpetuation of the antelope of the two States. The Hart Mountain Refuge furnishes also a much-needed haven for mule deer, sage grouse, and other wildlife.

A cold, dry, backward spring prevented normal forage growth on this refuge, and, though June rains improved conditions, water did not return to the long-dry lake beds and desert water holes as would be expected in ordinary seasons. There is promise, however, of a fair late growth of forage and consequent reseeding and revegetation. Reduction in the numbers of domestic stock permitted to graze on the refuge has been sufficient to make a greater growth of vegetation apparent, and a further reduction this fall will result in improved range conditions.

One law-enforcement case was brought to a satisfactory conclusion when the violator pleaded guilty to the possession of antelope and was fined and given a jail sentence, though half the fine and the jail sentence were suspended.

DESERT GAME RANGE

The Desert Game Range, Nevada, established by Executive order late in the last fiscal year, consists of 2,022,000 acres within the natural range of Nelson's mountain sheep, or desert bighorns. It is administered jointly by the Biological Survey and the Grazing Division of the Department of the Interior in connection with the organization of grazing districts for livestock under the Taylor Grazing Act of 1934. The Dixie National Forest is included in its southern part. Its high, narrow, desert mountain ranges once contained large bands of bighorns, but with unrestricted hunting, diseases contracted from the domestic sheep on their ranges, and depredations by predatory mammals and birds, especially upon lambs, the bighorns, in recent years, have just about held their own in some sections of their natural habitat and in others have become extinct. It is estimated that there are still about 150 on this range. Much of the Desert Game Range is barren, but under regulated grazing it should be possible to restore native forage, and, with the protection that will be afforded, the various forms of native wildlife should increase and thrive.

FORT PECK GAME RANGE

The 970,000-acre Fort Peck Game Range, Montana, was established by Executive order of December 11, 1936, also under the Taylor Grazing Act of 1934, to be administered by the Biological Survey and the Grazing Division of the Department of the Interior. It includes lands extending through six counties now being acquired by the War Department for the construction of a 254-foot dam and reservoir on the Missouri River in a giant flood- and soil-erosion-control project. Mule deer occur throughout the range, as well as a few antelope and sharp-tailed grouse, and white-tailed deer inhabit the river bottoms. Waterfowl will find a resting place on the reservoir.

NUNIVAK ISLAND WILDLIFE REFUGE

Nunivak Island Wildlife Refuge, in Bering Sea, Alaska, was originally reserved in 1929 as a preserve and breeding ground for native birds, wild game, and fur-bearing animals, and for use in conducting cross-breeding experiments with reindeer and native caribou. It is now serving also for experiments in the reestablishment of the musk ox in Alaska. Latest reports show approximately 5,000 reindeer on this island of about 1,111,000 acres, and experiments conducted in caribou cross-breeding have resulted in increased size and vigor of the offspring.

Four musk oxen from the herd received from Greenland in 1930 were transferred in 1935 from their range near Fairbanks to Nunivak Island, and in July 1936 the remaining 27 animals in the herd also were similarly transferred, by boat down the Yukon River to St. Michael, and thence by barge across about 300 miles of open water to Nunivak Island, where all arrived in fine condition. The herd has just about held its own during the 7 years it has been in Alaska, and now that all remaining of the original imports have reached breeding age and appear to be strong and virile, they should thrive and increase. The elimination of the predator menace, which had caused some losses, was one of the prime factors influencing the transfer of these valuable animals to the Nunivak Island Refuge, but there also they will find excellent range and adequate shelter from severe storms.

WILDLIFE CONSERVATION LAWS ADMINISTERED

Federal statutes for the conservation and restoration of wildlife are administered by the Bureau of Biological Survey as follows: The Migratory Bird Treaty Act of 1918, protecting birds that migrate between the United States and Canada, as amended June 26, 1936, to extend its provisions to the treaty concluded March 15, 1937, protecting birds that migrate between the United States and Mexico and regulating the movement of game mammals and parts thereof between the two countries; the Migratory Bird Conservation Act of 1929, authorizing the establishment of bird refuges; the Migratory Bird Hunting Stamp Act of 1934, as amended June 15, 1935, to aid in refuge establishment; the Lacey Act of 1900, as amended June 15, 1935, regulating the shipment in interstate or foreign commerce of wild animals, their dead bodies, or parts thereof, and the importation of live birds and mammals from foreign countries; a law protecting wildlife and property on national wildlife refuges (sec. 84, Criminal Code); and, through the Alaska Game Commission, the Alaska game law of 1925.[1]

REGULATORY ACTION

The regulations for 1936 under the Migratory Bird Treaty Act provided an open season on migratory waterfowl of 30 consecutive shooting days in each of three zones, instead of two zones as in the previous year—northern, intermediate, and southern. In the northern zone the season began on October 10, in the intermediate zone on November 1, and in the southern zone on November 26. Full protection was given three important species of waterfowl—the Atlantic coast brant, the redhead, and the canvasback duck, and similar protection was continued on snow geese in the States bordering on the Atlantic

[1] On June 17, 1937, a bill was introduced in the Senate to provide that the United States shall aid the States in wildlife-restoration projects, and it became law by approval of the President on September 2, 1937 (Public, No. 415, 75th Cong.).

Ocean, Ross's goose, wood duck, ruddy duck, bufflehead duck, and swans. The restrictions on taking waterfowl by means of bait or by the use of live decoys, and the three-shell limit on repeating shotguns also remained in effect. The regulation limiting waterfowl hunting to not farther from shore line or emergent vegetation than 100 feet was eliminated. The hours for shooting waterfowl and coots were, as previously, from 7 a. m. to 4 p. m., standard time, but Wilson's snipe was included with rails (other than coot), woodcock, mourning doves, and band-tailed pigeons, for which the shooting hours were from 7 a. m., standard time, to sunset. The daily bag and possession limits on migratory game birds were unchanged, but the interstate shipment of such birds was restricted to not more than 1 day's bag in a calendar week. While in a number of States the opening date for hunting mourning doves was September 1, the season in general was shortened 1 month.

The regulations for 1936[2] were published in the series of Service and Regulatory Announcements (BS–84), and the open season dates and other information regarding hunting were shown on a poster (No. 57–Bi). A migratory-waterfowl hunting-stamp poster also was issued. Other publications relating to conservation laws included the annual bulletin on Federal, State, and Provincial game laws (Farmers' Bulletin 1766); a mimeographed abstract of State fur laws affecting trapping seasons and possession, sale, and shipment of pelts (Leaflet BS–68); the annual directory of Federal, State, and Canadian game-protection officials (Miscellaneous Publication 244); and in the Department's Agricultural Statistics, 1937 (tables 542 and 543), hunters' licenses issued by States, with total money returns for the seasons 1934 and 1935, and sales of migratory-bird hunting stamps for the same years. Many press statements on wildlife-conservation subjects were issued for educational purposes and to advise the public of changes in the regulations, including those under the Alaska game law (Alaska Game Commission Circular 13).

The advisory board, Migratory Bird Treaty Act, an unofficial group of State game commissioners, naturalists, conservationists, and sportsmen, which for a number of years has furnished the Department information of a regional character as to the status of migratory waterfowl, was dissolved on May 26. Reorganization of the Bureau's advisory and cooperative system to meet current requirements on a more comprehensive scale is being effected.

WORK OF GAME-MANAGEMENT AGENTS

Under the supervision of regional directors, 36 United States game-management agents enforced the Federal game regulations in assigned districts, and during the hunting season were assisted by 23 deputy United States game-management agents, who operate in two- and four-man squads. Squad movements are directed by agents in charge of patrol districts, and these assistants were subject to immediate assignment in any part of the regions into which the country has been divided for facilitating field activities of the Bureau. All patrol units are equipped with fast automobiles, auto trailers, outboard motorboats, and speed launches. Seagoing cabin cruisers are in service on the east coast and in the Gulf of Mexico. Patrol officers wear uniforms of sand gray, of military design, trimmed in black. Shoulder emblems identify the officer as a Bureau employee and also indicate his regional assignment by number. In addition to the identifying uniform each agent is supplied with a distinctive badge and an identification card containing his photograph and signature. Uniforms are not worn during under-cover operations or during periods of intensive field campaigns.

Meetings of sportsmen, study groups, businessmen's organizations, and other public and private gatherings, and fairs are visited at various times by game agents in the interest of education in wildlife protection. Exhibits and illustrated talks play important parts in this program and tend to prevent violations of game regulations, thereby saving waterfowl for breeding purposes and reducing lawlessness. Recognition of the value of the new wild-fowl-protective measures is encouraging, and through the untiring efforts of the agents and cooperative State game officers many troublesome districts have been efficiently patrolled and violations reduced. This State cooperation has been of inestimable value and is highly appreciated.

[2] Regulations for the season 1937, adopted by the Secretary after the close of the fiscal year, were approved by the President on July 30, 1937 (2 F. R. 1615; S. R. A.–B. S. 88).

HAZARDS OF THE WORK

Physical encounters in self-defense have been noticeably reduced following the Nation-wide publicity given to the death of Federal enforcement officers at the hands of game-law violators. Survey agents in three instances during the past year met with resistance in enforcing game regulations. In one case of armed resistance, which is pending final disposition, the violator was placed under $3,000 bond pending trial. Three cases involving assaults on game-law enforcement officers were disposed of, one in Nebraska by fine of $25, one in Iowa by directed verdict for the defendant, and one in Colorado by dismissal. One case is still pending. Hazards of drowning, accidental wounding by intoxicated gunners, and accidental injury through failure of equipment or other causes also are risked by the agents, and exposure in extremely cold temperature brought one agent to the hospital when ice conditions resulted in an unavoidable motor-vehicle accident.

APPREHENSION OF VIOLATORS

There was a substantial increase of arrests and convictions. Duck bootleggers and sellers of illegal game, although still operating but on a reduced scale, have learned by severe penalties in the last 2 years that their enterprise is unprofitable. Agents and cooperators, in under-cover roles, have devoted many hours to investigating alleged duck sales. Night-club operators on the west coast suffered from inability to obtain ducks from their illegal shooters and bird runners by reason of the apprehension of waterfowl dealers who were detected in the act of transporting the contraband. The purchase by agents of migratory waterfowl at markets and eating places has become extremely difficult, for the illegal business has been harassed to the point that the prospective purchaser must be personally known to the bootlegger or bear a card of approval issued by the illicit dealer.

In 13 outstanding cases of killing or possessing ducks in close season, the defendants were assessed $4,550 in fines in addition to jail sentences of 4 to 8 months. Not all these persons were sentenced to jail, but when the defendant was recognized as a previous offender, or it was proved that possession was a step toward effecting eventual illegal sale, the courts were firm in pronouncing sentence.

Lacey Act cases involving painstaking investigations over a long period were successfully prosecuted in 16 instances, and numerous defendants are involved in cases not yet terminated in several States. In 3,636 case investigations presented to various States for completion, the fines aggregated $30,424. Not all the cases involved violations of the Lacey Act, but the evidence, as uncovered by Federal game-management agents, indicated State game-law violations that resulted in cooperative action with successful termination in State courts.

VIOLATIONS AND PENALTIES IMPOSED

MIGRATORY BIRD TREATY ACT CASES

Violations of the Migratory Bird Treaty Act reported by the Department for Federal prosecution showed an increase of 128 cases over the preceding fiscal year, and there were increases of 100 in the number of convictions and 101 in the number of cases disposed of (table 6).

TABLE 6.—*Cases of violation of the Migratory Bird Treaty Act disposed of during the fiscal year and cases still pending on June 30, 1937*

Disposed of	Number	Pending	Number
Convictions	522	From former year	[1] 447
Dismissals	69	New cases	610
Verdicts of not guilty	9		
Adjudged not guilty	30	Total	1,057
No bills found	25	Disposed of	733
Stricken with leave	5		
Nol-prossed	38	Pending at end of year	324
Prosecution abandoned	34		
Closed by death	1		
Total	733		

[1] There were 539 new cases reported instead of the 482 stated in last year's tabulation, which added 57 to the 390 cases reported last year as still pending.

In 96 of the cases reported, prosecution was not recommended because of lack of evidence, youthfulness of the accused, or other satisfactory reasons. Fines ranging from $1 to $750 and costs aggregating $11,428.21 were imposed in Federal courts. Six fines of $25 each and one of $50 were suspended. Verdicts of guilty were returned by juries in five cases. Jail sentences were imposed as follows: 1 day (2), 2 days (1), 3 days (1), 5 days (1), 12 days (1), 20 days (2), 30 days (11), 60 days (13), 3 months (4), 4 months (1), 5 months (1), 6 months (3), 8 months (1), an aggregate of 2,586 jail-days. Three jail sentences of 30 days, one of 3 months, and three of 6 months, totaling 720 days, were suspended. Sentence was suspended in 11 other cases. Defendants in 30 cases were placed on probation as follows: 1 for 30 days, 2 for 2 months, 1 for 3 months, 1 for 6 months, 15 for 1 year, 2 for 2 years, 1 for 3 years, and 7 for 5 years. Noteworthy cases were as follows:

Killing or possessing ducks in close season: California (2) $500 and 6 months each, and (2) $500 and 4 and 8 months each, respectively; Iowa (1) 21 days; Louisiana (2) 60 days each, (1) $75; Maryland (3) $50 each; Mississippi (1) $750 and 6 months (failed to appear in court at time appointed); Nevada (1) $100; New Mexico (1) $50; North Carolina (1) 60 days; Tennessee (3) $75 each.

Taking waterfowl by means of bait: Illinois (6) $25 each, (8) $10 each, (2) $200 each; Maryland (1) $25, (1) $250, (2) $10 each; Oregon (3) $5 each, (3) $100 each.

Selling ducks: Arkansas (1) 30 days; Illinois (1) (restaurant) $75; Louisiana (8) 60 days each, (1) 90 days, and in 2 others a husband was given 60 days in jail and his wife placed on probation for 5 years; Maryland (2) $500 each; Minnesota (1) 2 months.

Exceeding bag limit on ducks: California (1) $170; Maine (1) $100; Texas (2) $50 each.

Using motorboat to concentrate ducks: Kansas (2) $50 each.

Killing a canvasback duck: California (1) $50.

Killing wood ducks: South Carolina (1) 90 days.

Killing ducks from motorboat: Maine (1) $50.

Hunting coots in close season: Louisiana (1) 5 days, (2) 30 days each.

Killing doves in close season: Louisiana (1) $50.

Taking doves by means of bait: Kentucky (2) $10 each, (4) $50 each.

Hunting doves with gun not properly plugged: Kentucky (3) $36 each.

Hunting soras at night: North Carolina (6) 30 days each.

MIGRATORY BIRD CONSERVATION ACT CASES

Seven new cases involving violations of the Migratory Bird Conservation Act were submitted and three were pending from the previous year. Of these, 7 were closed—1 by a fine of $10, 4 by probation for 1 year, 1 by a jail sentence of 30 days, and 1 by dismissal—and 3 are still pending.

MIGRATORY BIRD HUNTING STAMP ACT CASES

Violations of the Migratory Bird Hunting Stamp Act reported since this statute became effective total 218. In the preceding years 41 were closed and the new cases submitted totaled 97. Of this year's pending and new cases, 74 were successfully concluded, 67 by fines of $1 to $25, aggregating $442, and 7 as follows: Suspended sentences for 5 years (2), probation for 1 year (2), probation for 2 months (2), and probation for 3 months (1). Twenty-nine other cases were disposed of as follows: Nol-prossed (3), dismissed (10), closed without prosecution (9), no bill (3), not guilty (4). Of 6 other cases, closed the preceding year but not reported for inclusion at that time, 1 was dismissed and 5 were closed without prosecution. Cases still pending total 68. Fines and costs imposed since the passage of the act have aggregated $1,437.

WILDLIFE REFUGE TRESPASS CASES

Four new cases under the law protecting wildlife and Government property on national wildlife refuges were reported and 4 were pending from the previous year. Of the 8, 5 were closed—2 in Arkansas, 1 in New Jersey, and 1 in North Carolina, by fines aggregating $70, and 1 in Oklahoma by a 6-month jail sentence—and 3 are still pending.

LACEY ACT CASES

Sixteen new cases under the Lacey Act were reported in the following States: Montana (2) and Ohio (1), involving the illegal interstate transportation of deer; Michigan (6), illegal interstate transportation of skins of fur animals; Texas (1), unlawful interstate shipment of live birds not properly marked; Maryland (2), unlawful shipping of ducks and quail and also mismarking of

packages; and Missouri (4), unlawfully transporting beaver skins. The Texas case was closed by a fine of $100 on the first count and a fine of $100 and 6 months in jail on the second count, which latter fine and sentence were suspended and the defendant placed on probation. The 6 Michigan cases were closed by jail sentences of 18 months (1), 13 months (2), 8 months (2), and 6 months (1); the 2 Maryland cases, which also involved the sale of ducks, by fines of $500 each and costs.

Information relating to infractions of State game laws was discovered by game agents operating under this statute as a result of inspections at fur-receiving centers in 21 States. Data relating to 2,626 apparently illegal shipments of skins of fur animals were furnished to game-protection officials in 39 States, Alaska, and Canada. In 18 States, 168 cases based on information originally furnished by the Bureau were closed by fines and costs of $3,424, and in 8 of these States jail sentences of 10 to 30 days were imposed in 15 cases. In 1,284 other investigations reported on by the States it was determined that shipments had been lawfully made, and in 117 others that prosecution would be inadvisable.

Evidence regarding 1,011 cases involving violations other than illegal interstate shipments of skins of fur animals were submitted to the game departments of 42 States. Fines and costs accruing to the States amounted to $27,000. In addition, in 28 cases jail sentences ranging from 1 to 60 days were imposed. Defendants were dismissed in 21 cases.

COURT ACTION ON THE BAITING REGULATION

Two cases involving the hunting of wild ducks by means of bait, wherein the defendants had entered pleas of not guilty, were concluded in Federal Court for the Southern District of Illinois in February, by fines of $200 and costs of $50 each. An appeal from the decision was taken.

A bill by certain hunting clubs was filed in the southern district of California during October to enjoin enforcement of the Migratory Bird Treaty Act regulations, charging that the treaty did not authorize Congress to give the Secretary of Agriculture power to regulate the means by which migratory birds could be taken. The temporary restraining order was in effect a few days, but the court promptly rendered a decision (which was appealed) by which the order was dissolved and the action dismissed, stating in its opinion:

> It would seem, in view of the conditions of the treaty, that it is contemplated that the United States may restrict the taking of edible wild fowl through certain specified periods of time and may create closed seasons when such game may not be taken at all. It appears logical that where an open season is provided, the qualification be imposed as a condition that during such open season baiting or luring of the wild fowl should not be permitted, because plainly that would result in a greater number being collected together and captured. The regulation referred to applies generally to all sections of the United States.

WILDLIFE CONSERVATION IN ALASKA

LAW ENFORCEMENT

Several changes were made in the regulations for the 1937–38 hunting and trapping season prescribed by regulations under the Alaska Game Law. An open season on beavers was provided throughout most of Alaska for the spring of 1938, with a seasonal bag limit of 10. Minor changes were made in the opening and closing dates of the open seasons on other fur animals, and the Kenai Peninsula west of the Alaska Railroad was closed to the trapping of minks, martens, land otters, weasels, foxes, and lynxes. The Commission, by a slight increase in the appropriation, was able to maintain 11 full-time game wardens in the field during the year, as against 8 for the previous year, though that number is insufficient for adequate patrol of Alaska's total area of 590,000 square miles and its 35,000 miles of irregular coast line.

During its twelfth operating year in Alaska, the Alaska Game Commission has received excellent support from local residents, members of the Territorial Legislature, and other officials. Regulations recommended by the Commission and enforced by the wardens have been changed only after careful study of the conditions under which many people in outlying districts in the Territory must live. The importance of fur animals to the Territory's 30,000 native Indians, Eskimos, and Aleuts, besides several hundred white trappers, is realized, as is the value of Alaska's big game as an attraction to nonresident hunters, who spend hundreds of dollars annually in their shooting and photographic expeditions into the Territory.

WILDLIFE RESTOCKING PROJECTS

The only restocking work accomplished in Alaska during the year was the transplanting of 27 musk oxen from the Bureau's experimental station at Fairbanks to Nunivak Island in Bearing Sea, already mentioned (p. 51). The 8 elk transported to Afognak Island 8 years ago have increased to a herd of nearly 100, and the original herd of 23 buffalo placed in the Big Delta section near Fairbanks has increased to approximately 140. Neither the elk nor the buffalo have required artificial feeding. The 558 snowshoe rabbits transplanted from the Alaska Railroad belt in 1934 to Kodiak Island, with funds provided by the Civil Works Administration, have now become thoroughly established. Numerous other transplantings made in past years, involving mountain goats, black-tailed deer, beavers, muskrats, martens, squirrels, marmots, and ring-necked pheasants, show promise of success.

PREDATORY-ANIMAL CONTROL

Despite the Territorial bounty of $20 each on wolves and coyotes, damage by these predators has continued to such an extent that the Territorial Legislature appropriated further funds for a cooperative program with the Bureau of Biological Survey to employ expert trappers to demonstrate control methods. The greatest damage appeared to be centered among the reindeer herds of the Arctic coast.

IMPORTATION AND OTHER PERMITS ISSUED

FOREIGN SPECIES EXCLUDED

Several unsuccessful efforts were made during the year to import bullfinches and other species of birds excluded from this country by order of the Secretary of Agriculture of December 26, 1935, and by subsequent Treasury Department regulation, and it is again pleasing to report that no forbidden species of bird or mammal has established a foothold in the United States since 1900, the year in which the law regulating importations of wild birds and other animals became effective.

Incident to the going into effect on March 15, 1937, of the convention between the United States and Mexico for the protection of birds migrating between the two countries, it became necessary to refuse permits to import, usually from Cuba and Mexico, certain species except by museums and other scientific institutions and by individuals holding scientific possession permits from the Department. By virtue of the Mexican treaty there is prospect of early suppression of the cage-bird traffic in a number of kinds of song and insectivorous birds, including painted buntings, indigo buntings, goldfinches, and orioles, which have heretofore been captured in Cuba and Mexico and freely commercialized in those countries and exported to this country for similar purposes. These species are also captured to a considerable extent in some of the Southern States and thus introduced into the cage-bird traffic. It is gratifying to report that the Department's action with reference to the capture and commercialization of these migratory birds has already stimulated some of the State conservation departments to action of a similar nature under the powers conferred upon them by their conservation laws. Prior to the Mexican convention, these species were not within the scope of general Federal protection and therefore were admissible as imports.

Eight flying foxes (*Pteropus personatus*) that arrived in a shipment from India on August 28 were not only refused entry but were killed by the customs officials at the dock. The dead bodies, however, were permitted to be delivered to the Staten Island Zoological Society for scientific research work. About September 4, two meercats (*Cynictis penicillata*) arrived at New York on a steamer from South Africa and also were killed by the customs officials. One crested myna (*Aethiopsar cristatellus*) was refused entry at San Francisco, and two bullfinches (*Pyrrhula pyrrhula*) and two European yellowhammers (*Emberiza citrinella*), discovered in a shipment of canaries arriving at New York last October, also were excluded.

Four goldfinches, one of which had died from suffocation, were seized on May 14 by a customs guard at New York from a member of the crew of a large ocean passenger vessel. The would-be smuggler had tied the birds around his ankles inside his socks. Before the legal division of the Customs Service he was fined $45 and warned that the next offense would bring a heavier penalty.

SPECIES ENTERED UNDER PERMIT

BIRDS

There were 1,590 permits issued during the year, including 56 at Honolulu, Hawaii, for the importation of foreign birds and mammals, and 278 importations were inspected. A total of 300,817 foreign birds were imported into continental United States as compared with 230,140 last year, including 162,700 canaries, 3,765 parrots, 101,396 Mexican quail, 3,482 Hungarian partridges, 1,420 pheasants, and 28,054 miscellaneous birds, the increase over the preceding year being especially notable in the numbers of parrots and bobwhite quail. At Honolulu, Hawaii, 2,337 foreign birds were entered, and at San Juan, Puerto Rico, 84.

Entries of Hungarian partridges from Canada diminished considerably, but several large shipments of these birds were imported from Europe, all for propagation in Pennsylvania. Many other species of partridges were imported from India and the Orient, including 20 spectacled partridges (*Francolinus* sp.) from Singapore, Straits Settlement, and 1 black partridge (*F. francolinus*) and 2 rock partridges (*Ammoperdix griseogularis*) from India.

Pheasants in great variety were imported, including 4 white-crowned Kaleege pheasants (*Gennaeus leucomelanus hamiltonii*), 8 Nepal Kaleege pheasants, (*G. leucomelanus*), 9 Impeyan pheasants (*Lophophorus impejanus*), 21 monal pheasants (*L. sclateri*), 4 Rheinhart's pheasants (*Rheinardia ocellata*), and 4 koklass pheasants (*Pucrasia* sp.), from India; 7 Cabot's tragopans (*Tragopan caboti*), 4 Elliot's pheasants (*Calophusis ellioti*), 4 Reeves's pheasants (*Syrmaticus reevesii*), and 4 Manchurian eared pheasants (*Crossoptilon mantchuricum*), from China; 4 Swinhoe pheasants (*Hierophasis swinhoii*), 7 fire-backed pheasants (*Lophura rufa*), 4 Siamese firebacks (*Diardigallus diardi*), and 3 versicolor pheasants (*Phasianus colchicus versicolor*), from Japan; and 1 argus pheasant (*Argusianus argus*), from Singapore.

Quarantine restrictions were maintained by the Public Health Service on the importation of birds of the parrot family, and no new outbreaks of psittacosis were reported, despite a substantial increase in the number of parrots entered during the year. Among these parrots were 2 red-faced lovebirds (*Agapornis pullaria*) and 5 gray parrots (*Psittacus erithacus*), from Africa; 50 chocolate conures (*Aratinga pertinax aeruginosa*), from Colombia; and 1 dwarf macaw (*Ara maracana*), from the Canal Zone.

Other interesting importations were 25 crowned finches (*Coryphospingus pileatus*) and 10 archbishop tanagers (*Thraupis ornata*), from Venezuela; 11 mockingbirds (*Mimus gilvus melanopterus*), 12 Colombian quail (*Odontophorus atrifrons*), and 7 Colombian rails (*Aramides c. cajanea*), from Colombia; 1 yellow-bellied blackbird (*Pseudoleistes virescens*), 6 spectacled ibises (*Theristicus caudatus*), and 6 horned screamers (*Palamedea cornuta*), from Brazil; 4 Bonaparte's tawny robins (*Turdus grayi casius*), 3 Panamanian woodpeckers (*Centurus subelegans wagleri*), 4 Cassin's doves (*Leptotila cassini*), and 2 stripe-breasted saltators (*Saltator albicollis*), from the Canal Zone; 1 sickle-billed bird of paradise (*Falcinellus meyeri*) from New Guinea; 1 black tanager (*Tachyphonus rufus*), from Trinidad; 1 black-naped oriole (*Oriolus indicus*), from Celebes Island; 2 Laysan albatrosses (*Diomedea immutabilis*), from Midway Island; 2 broad-billed weavers (*Amblyospiza albifrons*), 1 imperial ant pitta (*Grallaria imperator*), and 10 queen wydahs (*Tetranura regia*), from Africa; 5 satin bower birds (*Ptilonorhynchus violaceus*), 1 red-tailed oriole (*Oriolus traillii*), 1 tree pie (*Dendrocitta rufa*), 2 pearl turtle doves (*Spilopelia chinensis*), and 30 Chilean flamingos (*Phoenicopterus ruber chilensis*), from India; 13 plum finches (*Aidemosyne modesta*), from Australia; 1 jay thrush (*Dryonastes chinensis*), from China; 1 Japanese warbler (*Hororuis cantans*) and 4 Mongolian larks (*Melanocorypha mongolica*), from Japan; 1 helmet-crested hummingbird (*Orthorhynchus exilis*) and 1 ruby topaz hummingbird (*Chrysolampis elatus*), from Central America.

Bobwhites imported from Mexico aggregated 101,396, the largest number for a single year since 1900, when importations were first subjected to Federal permit. The special regulations governing the importation of bobwhites from Mexico, in effect since December 1927, were amended on October 23, by adding Nogales, Ariz., to the ports of entry and by changing the importation season to conform with the Mexican exporting season of 4 months, from November to March. The quails imported were distributed to the following States: Mississippi, 40,676; Indiana, 24,831; Texas, 15,543; West Virginia, 6,669; Kentucky,

5,768; Florida, 2,136; South Carolina, 846; Tennessee, 753; Virginia, 425; North Carolina, 341; Pennsylvania, 249; Alabama, 200; Iowa, 175; New York, 174; Oklahoma, 163; Illinois, 154; and the rest in small lots of less than 100 each to several other States, and 200 to Hawaii.

MAMMALS

Continued interest was manifest in the importation of black bear cubs from Canada, the number imported being 113, as compared with last year's 102. These cubs are used principally for exhibition at amusement parks and roadside menageries and stands. Due to the fact that several children and other persons had been seriously injured by bears kept in captivity, New York now requires a State license for the entry of these mammals and for keeping them in captivity. Federal permits, therefore, are not issued for importations destined to New York State unless the importer forwards a copy of his State license with his application. A few Russian brown bears and polar bears also were imported.

Importations of monkeys included one gorilla and several baboons, chimpanzees, mangabeys, drills, mandrills, hussar or military monkeys, and pigtailed monkeys, from Africa; Makassar black monkeys, from India; orangutans, gibbons, and langur monkeys, from Singapore; macaques, from Java and the Philippines; and marmosets, ringtails, spider monkeys, moss monkeys, woolly monkeys, capuchins, owl monkeys, sapajous, and saki monkeys from Central America and South America. The total number of the popular rhesus monkeys imported during the year was 12,421.

A considerable number of South American animals were brought in by passengers for pets, including coatimundis, honey bears, kinkajous, agoutis, and pacas. Among the more interesting mammals imported were 1 giant panda (*Aeluropoda melanoleuca*) from Shanghai, China, captured near the Tibetan border, about 2,000 miles from Shanghai, when it was about a week old; 8 tricolor squirrels (*Sciurus raffalii*), from Singapore; 2 giant gray kangaroos (*Macropus giganticus*), 2 Bennet's kangaroos (*M. bennetti*), 2 dorsalis kangaroos (*M. dorsalis*), and 1 wallaroo (*M. robustus*), from Australia; 2 Tasmanian devils (*Sarcophilus ursinus*), from India; 1 palm cat (*Nandina binotata*), 6 Turkestan porcupines (*Hystrix hirustirostris*), 2 crested porcupines (*H. cristata*), 1 ratel (*Mellivora ratel*), and 1 bush pig (*Orycteropus apa*), from Africa; 1 crab-eating raccoon (*Procyon cancrivorus*), from Colombia; and 10 giant anteaters (*Myrmecophaga jubata*) and 9 maras (*Dolichotis patagonica*) from Brazil.

Seventy-six chinchillas were imported from Chile after a lapse of several years during which many attempts were made to obtain some of these valuable little fur-bearing animals. Chile and other South American countries stringently protect chinchillas by law and require special exportation permits. Before permits to import chinchillas into the United States will be issued, therefore, applicants must forward to the Department a copy of their export permits. Of the chinchillas imported, 71 were shipped to California and 5 to Missouri.

PERMITS UNDER THE MIGRATORY BIRD TREATY ACT

FOR SCIENTIFIC PURPOSES

Under the new policy effective July 1, 1936, the Bureau discontinued the issuance of annual permits to take migratory birds and their eggs for scientific purposes, and substituted conditional permits without time limitation but subject to revocation at the discretion of the Secretary and to forfeiture for violation of Federal or State conservation laws. During the year, 1,721 of these conditional permits were issued, 2 of which were canceled, leaving 1,719 outstanding at the close of the year.

All outstanding permits to possess, buy, sell, exchange, and transport migratory birds and their eggs were recalled during the year for elimination of the privileges of purchasing and selling specimens. At the close of the year, 303 of these revised permits were outstanding. For possessing one or more specimens found dead and salvaged, 226 permits were issued. Permits were issued to 215 persons to take migratory birds for banding.

FOR WATERFOWL PROPAGATION

During the year 21 permits were issued authorizing the taking of migratory waterfowl for propagation, each permit limiting the species and number of each to be taken and the time for taking them, and 289 to possess such waterfowl. With 415 permits surrendered, canceled, or revoked, 3,986 were outstanding at the close of the year.

Reports submitted by permittees disclose that 3,673 wild geese and 55,781 wild ducks were raised in captivity. Of the latter 50,622 were mallards, 3,870 black ducks, and the remainder principally wood ducks, teals, ringnecks, wigeons, pintails, and redheads. Sales of propagated migratory waterfowl for food included 16,122 ducks and 391 geese; and for propagation, 9,236 ducks and 1,334 geese. Of propagated birds, 12,017 ducks and 222 geese were released for return to the wild state.

PERMITS FOR SPECIAL USES OF REFUGES

For grazing, hay harvesting, and other uses on national wildlife refuges, including the big-game preserves, 227 special-use permits, some requiring the payment of a fee, were issued, exclusive of permits issued by the supervisory officers of the Wichita Mountains, the Upper Mississippi River, and the Aleutian Islands Refuges. The revenue derived aggregated $26,622.75.

COOPERATIVE CONTROL OF PREDATORY AND OTHER INJURIOUS ANIMALS

The year's operations in predator and rodent control involved expenditures of $594,531 from regular departmental appropriations, supplemented by $382,673 by cooperating States, and $903,919 by cooperating counties, livestock associations, and others, and about $1,125,800 of emergency funds on work under Biological Survey supervision. Predators taken through this cooperation, which aggregated 89,289 and exceeded last year's records by 16,162, consisted of 80,299 coyotes, 1,007 wolves, 7,471 bobcats and lynxes, 1 ocelot, 299 bears, and 212 mountain lions. Rodent control involved the treatment of 34,652,418 acres infested with prairie dogs, ground squirrels, pocket gophers, jack rabbits, porcupines, field mice, cotton rats, kangaroo rats, and woodchucks. In addition 213,619 premises were treated in cooperative campaigns for the control of common brown rats. Predator-control activities were extended to the Territory of Alaska.

Publications issued during the year on control procedure and matters related to control operations included Circular No. 423, The House Rat, and Farmers' Bulletin No. 1768, Trapping and Transplanting Live Beavers, and the following mimeographed leaflets: Rodent Control Aided by Emergency Conservation Work (BS–54, revised with illustrations), Suggestions on Trapping Coyotes and Wolves in Alaska (BS–62), and Directions for Destroying House Mice (BS–78).

PREDATORY ANIMALS

The continued increase of predators, especially coyotes, over wide areas of the Western States, principally west of the one hundredth meridian, has aroused added interest in their control on the part of cooperating organizations, and State legislatures in Texas, Oregon, Oklahoma, Colorado, and Idaho have substantially increased their appropriations for cooperative work with the Bureau. State funds were thus increased from $75,000 to $100,000 in Texas, from $16,000 to $28,000 in Oregon, and from $6,500 to $15,000 in Oklahoma. The Colorado Legislature increased the levy from 4 to 6 mills on assessed valuations of stock sheep and goats and in addition appropriated $7,500; the Idaho Legislature increased the levy from 5 to 10 mills on assessed valuations of sheep. Other cooperators, including counties, livestock associations, predatory-animal clubs, and individuals, expended additional funds for the protection of livestock from depredations by stock killers.

WOLVES AND COYOTES IN ALASKA

Early in the year predator-control work was resumed in Alaska in cooperation with the reindeer service and the Office of Indian Affairs of the Department of

the Interior, by the assignment of a district agent of the Survey to the Territory for the purpose of investigating depredations of wolves and coyotes, particularly to reindeer and game species. The Territorial Legislature later appropriated $15,000 for the employment of demonstration trappers and the purchase of supplies. Efforts are being expended to familiarize native trappers with methods of taking the larger predators and in making it possible for them to obtain necessary equipment. The reindeer, herded formerly by constant attendants, have been allowed, during recent years, to roam more or less and now are corralled only at certain seasons. This change in herd management has caused the reindeer to scatter widely over the ranges and has made it possible for the increasing numbers of wolves and coyotes to make greater inroads on the herds. An outstanding example is furnished by a reindeer company near Skungnak, which reported its herd nearly wiped out by predators; whereas in 1935 it had an actual count of 3,000 head, in December 1936 it could gather only 650, with a possibly equal number somewhere on the range. Investigations have shown wolves to be present in the immediate vicinity of both reindeer and caribou herds. Licensed hunters and trappers reported to the Alaska Game Commission the taking of only 514 wolves and coyotes during the fiscal year 1930 but a steady increase from year to year, until in 1936 the total was 1,236. These figures do not represent all wolves and coyotes taken in Alaska, but they do give an indication of the alarming rate at which these predators are increasing.

PREDATORS IN ALABAMA

An expert predatory-animal hunter was assigned to work in Alabama, where wolves and coyotes were destroying livestock and poultry, and on a relatively small area, he reported taking nine wolves and one coyote. Removing these animals materially lessened the losses among the livestock and poultry in the State. Investigations also were made looking toward the control of bobcats and foxes on national forests in Georgia and Tennessee, where these predators have become so abundant as to warrant control for the protection of game.

EMERGENCY PROGRAM IN PREDATOR CONTROL

Through the medium of the W. P. A. in cooperation with various State organizations and departments, predatory-animal control operations were conducted in Utah, Idaho, Wyoming, Montana, and Oregon. These projects supplemented other control work and made it possible to give livestock and game some degree of protection from predators on areas where protection would otherwise have been impossible through regular channels.

RODENT CONTROL

RATS IN HAWAII

Early in the year a district agent was assigned to Hawaii to correlate rat-control projects in cooperation with the University of Hawaii, through its agricultural experiment station and extension service, and the Territorial Board of Health. Financed largely by Agricultural Adjustment Administration funds, the control work was inaugurated for the protection of pineapple, sugarcane, coffee, and macadamia nuts from rat depredations and for the improvement of health conditions within the Territory, especially on two specific areas where bubonic plague is present. Typhus fever and trichinosis also are present on certain islands, and rat carriers are responsible to a certain extent for the prevalence of these diseases. On certain pineapple plantations on the island of Lanai, the common brown, or Norway, rats had become so abundant that they damaged as high as 60 percent of the pineapple fruits. On sugarcane areas experimental analysis for sugar content and counts of damaged cane indicated that on a single plantation of 17,000 acres rats were responsible for a direct annual loss in sugar of about $147,000. Rat damage is also a serious factor in the Kona coffee-growing section, where the rodents nip off branches that ordinarily bear coffee berries for a 2-year period. This damage on certain plantations amounted to 10 to 15 percent of the crop. Application of control methods has materially lessened the losses.

Research in connection with the rat-control project in Hawaii was conducted for developing more efficient baits and improving and developing specific procedure in field application. Considerable improvement in bait material and in methods of distribution was made in the infested pineapple, coffee, and maca-

damia nut areas, but the methods of procedure in the sugarcane areas need further development and refinement. A laboratory and bait-production plant has been established at Honolulu for experimenting with rat-control baits and for preparing them for shipment to the various islands of the Hawaiian group. Means of canning perishable rat baits have been perfected so that they can be shipped as needed.

EMERGENCY RODENT-CONTROL PROGRAMS

Cooperative rodent control was conducted during the year through the medium of the Emergency Conservation Work, Works Progress, Agricultural Adjustment, Resettlement, and Emergency Relief Administrations. The Emergency Conservation Work projects were conducted cooperatively with the Forest Service and the Soil Conservation Service of the Department of Agriculture and with the Division of Grazing, Bureau of Reclamation, and Office of Indian Affairs of the Department of the Interior. All work was supervised by the Biological Survey and by field workers specifically trained by the Bureau in systematic rodent-control operations. Work was undertaken only where a specific need for the control of rodent pests was evident and where such control would lead to the future restoration and development of wide areas of grazing lands and for the protection of irrigation projects, agricultural crops, forest trees, and horticulture.

In California 75 percent of all structural failures of ditches, contours, and terraces constructed under soil conservation programs have been traced to the activities of pocket gophers. Throughout the farm-forestry project areas within the Dakotas, Nebraska, Kansas, Oklahoma, and Texas, it was necessary to maintain a vigilant control program to prevent young three plantings from being destroyed by rodents, especially by jack rabbits.

RODENTS AND SYLVATIC PLAGUE

The Public Health Service has reported the presence of sylvatic plague among native rodents in additional localities during the year, showing a further spread of this epizootic. Measures for the control of rodent carriers at plague foci have been continued in California, Idaho, and Montana and have been extended in Oregon and inaugurated in Nevada and Utah. The existence of sylvatic plague among native rodents in the Western States continues to present a serious situation.

In California the plague was found only in the coastal sections until 1934, when it was recognized as the cause of increased mortality among ground squirrels (*Citellus beecheyi*) in interior counties. Later, dead and dying Oregon ground squirrels (*C. oregonus*) in Modoc County, in the northeastern corner of California, were found to be infested with plague, and in May 1934 a sheep herder employed on the desert near Lakeview, Oreg., died of the disease, the bubonic form in man. The United States Public Health Service found that the Oregon Columbian ground squirrels (*C. columbianus*) in Lake, Grant, and Wallowa Counties, Oreg., were carriers of the plague. Later it was discovered among Richardson's ground squirrels (*C. richardsonii*) in Beaverhead County, Mont., and in the same vicinity both fleas and lice taken from a golden-mantled marmot (*Marmota flaviventris nosophora*) proved positive for plague, the first American record that these rodents could carry the disease.

In May 1936, sylvatic plague was discovered in fleas taken from the Nevada ground squirrel (*Citellus richardsonii nevadensis*) near Elko, Nev. It had previously occurred among rodents in the Lake Tahoe section. In July 1936, public-health authorities found plague among the Uinta ground squirrels (*C. armatus*) in Bonneville County, Idaho. In August 1936, a boy in Beaver County, Utah, bitten by a wounded rock squirrel that he had picked up, contracted bubonic plague. At that time ground squirrels, prairie dogs, and jack rabbits were reported to be dying in that vicinity from some unknown cause. Authorities of the United States Public Health Service, conducting an investigation, found that the disease was carried by a marmot (*Marmota engelhardti*), the Utah prairie dog (*Cynomys parvidens*), and rock squirrels (*Citellus grammurus*). Previously it had been discovered in California that the wood rat (*Neotoma cinerea*), the Sierra chickaree (*Sciurus douglasii*), and the white-footed mouse (*Peromyscus*) could transmit the infection. Thus it is seen that at least eight species of squirrels, as well as wood rats, mice, marmots, and prairie dogs, are victims of sylvatic plague.

The constantly increasing list of rodents that may serve as hosts for the disease-carrying fleas arouses speculation as to the present status of sylvatic plague. That rodents fluctuate in numbers in a particular locality has long been a familiar observation. Climatic conditions together with increased food supplies resulting from the extension of irrigation and the cultivation of many western valleys have favored the reproduction of native rodents. Outbreaks of plague among rodents have often been recorded, and since the discovery of tularemia in southern California in 1911, the decimation of rodent population has been commonly attributed to this disease. The widespread occurrences of sylvatic plague that have been noted since public-health authorities have increased the scope of their examinations of squirrels and other suspected plague carriers now suggest that many of the epizootics among wild rodents might have been caused by sylvatic plague rather than by tularemia. The recent discovery of plague over such widely separated areas may not be due so much to a spread of the disease among rodents as to the development of more intensive investigations and refinement of technique: it is possible that the disease may have been present but unrecognized for many years. Every effort to prevent its further spread is imperative.

SUPPLY DEPOT AND LABORATORY

Congressional legislation at the close of the preceding fiscal year, authorizing the establishment of a game-management supply depot and laboratory, made it possible for the Bureau to purchase in April a tract of land in Pocatello, Idaho, including a structure thereon that formerly had been rented as a bait-mixing station. Arrangements are now being made for the construction of an extension to the present building to facilitate the storage and handling of miscellaneous supplies, for use in various field activities of the Bureau.

In cooperation with the Pocatello (Idaho) Chamber of Commerce, the supply depot has prepared scientifically treated baits for distribution to cooperators throughout the United States. This year's production totaled 2,180,021 pounds, an increased output sent primarily to cooperators for the control of rodents on privately owned lands.

In addition to the preparation of bait materials the supply depot has distributed quantities of bait-mixing ingredients, ammunition, refrigerators, water heaters, ranges, and other miscellaneous official equipment. One carload of predatory-animal traps was also distributed to cooperators. Production there of standard adjustable pocket-gopher probes has materially assisted cooperative control projects in the several States.

CONTROL METHODS RESEARCH

The Control Methods Research Laboratory at Denver, Colo., has made progress during the year along several lines of investigation. Outstanding studies were concerned with lethal doses of bait material for birds and mammals, developing fumigants, control of mice in orchards, control of rats, control of rodents in relation to range and to forest regeneration, and the migration of coyotes. Circular No. 409, on The Effect of Thallium on Plant Growth, was issued, showing lack of harmful effects on vegetation following field operations; and a leaflet (BS–91) described Research Studies in the Control of Destructive Mammals.

LETHAL DOSES FOR BAIT MATERIAL

Studies of the effect of strychnine alkaloid on horses, Canada geese, mallard ducks, Chinese pheasants, Hungarian partridges, and the Oregon ground squirrel have been made to determine the quantity required for lethal doses. It was found that susceptibility of birds to strychnine varied greatly and that the horse is considerably more susceptible than other domestic livestock studied. These studies, however, revealed that when the recommended standard field practices are followed, the Biological Survey formulas for rodent control are noninjurious to game birds and domestic stock.

BURROW FUMIGANTS

Further experiments were made with poison-gas pyrotechnic cartridges for fumigating rodent burrows. It has been found that the cartridges as now developed burn well and are convenient to handle in the field but that the warn-

ing factor to rodents in the burrow is still too high and the toxicity of the gas or gasses apparently too low. The variability of soil type, temperature, and moisture make it imperative that a successful rodent-control fumigant be effective over the widest possible range of these factors. Further investigations on this line are essential.

ORCHARD-MOUSE CONTROL

To study the problem of mouse control in New England orchards, a field investigator was assigned to the region in September. It has been found that mice (*Microtus*) quickly detect the presence of strychnine incorporated in a bait material and that they will eat the bait sparingly until a large percentage is consumed without harm. Apples cut into quarter-inch cubes are best accepted, except where windfall apples are available.

During the winter of 1936–37, mouse damage to orchards in New England was of an unusual nature, because of an extremely mild season and an absence of snow covering. Under these conditions it was found that, instead of girdling the trees above the ground, under cover of snow, the mice tunneled underneath the surface to the roots and then along the roots to the root crown, girdling it and thus killing many trees. In one 5-acre, 12- to 15-year-old orchard, 90 percent of the trees had been entirely girdled by mice. In another orchard of 7,000 trees, 25 to 35 percent were damaged by mice during the winter, even though the orchardist had so placed mounds of cinders as to give the mice no opportunity of girdling the trees above the ground.

In Connecticut, 350 to 400 apple trees were girdled by pine mice in a 12-year-old orchard, the first time the pine mouse (*Pitymys*) has been found to be present in the State. So far as known, however, it has not as yet extended northward to the other New England States. Orchardists in this locality had not been aware of what the mice were doing until the matter was called to their attenion by the field investigator. Progress has been made in developing practical methods of mouse control in this section and in impressing upon the orchardists the necessity of proper application of control methods.

IMPROVED RAT BAITS

Progress has been made in the development of a permanent rat-control bait for use in and about buildings, and the results obtained in three cities are encouraging.

RODENTS AND RANGE AND FOREST REGENERATION

Continued studies looking toward the control of rodent pests, especially mice, in their relation to the regeneration of Douglas fur, Sitka spruce, and western hemlock in Washington and California, have developed effective bait materials and field procedure. Pocket gopher plots on the Ochoco National Forest, Oreg., have been continued, where studies have been made relative to damage by these rodents to grazing areas. These plots are showing the heavy damage by pocket gophers to the range and that some grazing of livestock aids in keeping the range in better condition where pocket gophers are present.

COYOTE MIGRATION

Studies have been continued on the migration of coyotes in western livestock range areas. Several young coyotes have been tagged and released on summer and winter grazing areas in order to learn about their migrations from their native localities. Interesting and valuable information for use in the control of this mammal is expected from this experiment.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D.C. - - - - - - Price 10 cents

REPORT OF THE CHIEF OF THE BUREAU OF CHEMISTRY AND SOILS, 1937

United States Department of Agriculture,
Bureau of Chemistry and Soils,
Washington, D. C., August 31, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I present herewith the report of the Bureau of Chemistry and Soils for the fiscal year ended June 30, 1937.

Sincerely yours,

Henry G. Knight, *Chief.*

CONTENTS

24696—37——1

INTRODUCTION

The production of agricultural materials through the medium of plant growth depends on chemical processes, energized by sunlight, in which the raw materials are carbon dioxide, oxygen, and nitrogen of the air and numerous soil constituents including water, inorganic compounds derived from minerals, and organic compounds formed through the action of micro-organisms on the products of former plant and animal life. Whether or not these chemical processes go on depends not only on the availability of energy, but also on the availability of raw materials. Since the gases of the atmosphere and sunlight, in most places and at certain seasons, are always sufficiently abundant, it is the availability of raw materials from the soil which determines the course and efficiency of nature's chemical processes that result in agricultural plant and animal products. One of the most important of these raw materials is water, the availability of which in suitable quantity depends primarily on the physical and chemical properties of the soil colloids which make it possible for soils, in varying degree, to retain water for fairly long periods after wetting. The properties of their colloids also make it possible for some soils to retain, in spite of frequent wetting with excessive quantities of water, inorganic and organic plant foods, naturally present or added as fertilizers, and to supply them, as needed, to growing plants.

The kinds and quantities of raw materials suitable for the production of plants vary in different soils and, consequently, the kinds and quantities of plants that different soils can produce vary. Some soils contain substances which interfere with the natural chemical processes involved in plant growth and thus produce abnormal or unhealthy plants or alter the resulting products so that they are not suitable raw materials for the chemical processes involved in animal growth or sustenance. Moreover, some soils are deficient in one or more of the raw materials required for the normal course of the chemical processes involved in the production of certain plants. Such deficiencies may prevent the production of particular plants entirely, they may result in abnormal or unhealthy plants, or they may so alter the composition of the resulting products that they cause unhealthy conditions in animals consuming them as food.

Food is one of the prime necessities of human and animal life, and the soil is the principal source of food. The agricultural utilization of soils results in many products that contribute to the needs and desires of human beings, but its primary purpose is, and probably always will be, the production of food. The composition of foods and their utility for maintaining human and other animal life in a state of health depends on the composition of the soil. The abundance of these food products depends largely on the abundance of water and plant foods in the soil, which, in turn, depends in large measure on the ability of the soil colloids to retain them.

The Bureau of Chemistry and Soils is a research organization engaged in the application of chemistry and related sciences to the study of soils, soil-amendment materials, and soil products; and it is, therefore, concerned with the fundamental things in agriculture. On the basis of the scientific knowledge gained in these studies, soils are classified according to origin, characteristics, and usefulness for various agricultural purposes, and the distribution of the various classes and types of soils is shown on maps of counties or other comparatively small areas. The existence of deleterious substances in certain soils and their effects on the composition and utility of plants is noted, as well as deficiencies of certain substances necessary for vigorous and healthy plant growth and the need for special fertilizer or other soil-amendment materials.

Conditions contributing to the maintenance or increase of soil fertility through the nitrogen-fixing and other chemical activity of micro-organisms and through the addition of inorganic and organic plant foods are studied; also the suitability of various substances and mixtures of substances for correcting soil deficiencies, and economical methods for producing efficient fertilizers from available raw materials.

Plants and plant products are studied both with regard to composition and as to how their composition and utility for food and other purposes are affected by the composition of the soil. The influence of feeds on the composition and properties of certain animal products is also studied.

Means for preventing deteriorative chemical changes in agricultural products, due to enzyme action, micro-organisms, and other agencies, are investigated. Much attention is given to the best utilization of agricultural products through

chemical processing. Studies are made on their use for new and better food products and on the use of inedible products and byproducts in chemical industries. Nonfood uses through chemical processing are being sought for food crops produced in excess of the needs for food purposes.

The results of the work of this Bureau during the year, along these various lines, are reported briefly in the following pages. Further information concerning many of the subjects discussed may be obtained from the 274 publications emanating from the Bureau during the year and listed at the end of this report.

CARBOHYDRATE INVESTIGATIONS

SUGARS, SUGARCANE, AND SUGAR BEETS

Investigations on the chemistry and technology of the production of cane sugar were carried on at the Houma, La., field station, in cooperation with the Bureau of Plant Industry, and also at the Audubon Sugar School in Baton Rouge, La., where improved working facilities became available during the year through cooperative arrangements with the College of Pure and Applied Science of Louisiana State University.

Studies pertaining to the production of direct-consumption sugar of improved quality and byproduct molasses were undertaken. A result from this work was the development of a process of reducing the sulphite content of edible molasses by the use of chlorine, thereby improving its quality and marketability. A public-service patent (No. 2,043,911) covering this process has been granted.

In the production of raw sugar in Louisiana, it is customary, when crystalization facilities are lacking, to allow the second molasses, after it is boiled to a heave density, to crystallize for several months before separating the final molasses. Frequently this separation is extremely difficult to accomplish, and the reasons for this are quite obscure. A fundamental study of the manufacture of this magma sugar was, therefore, initiated. Clarification of the juices prior to crystallization doubtless has a very important influence on the workability of the massecuites in the vacuum pan and centrifugals, and considerable attention was given to a study of the clarification characteristics of the juices from different varieties of cane and to improving the clarification of juice by the development of mud-separating devices, as well as to efficient processes of sugar crystallization.

Studies in past years have shown that the juice of each variety of sugarcane tends to have definite characteristics with respect to behavior during clarification. From analytical and clarification studies on the same juices it appeared that these characteristics of individual varieties depend on the kinds and quantitative relationships of nonsugar substances present, and that the natural tendency of a variety may be intensified or minimized by conditions of growth. Recent work has shown that different fields of the same plantation, when planted with the same variety, produce cane of decidedly variable composition with juices of very different clarification qualities. During the last season a special study was made of the variety Co. 290 which formed the major part of the crop and was grown almost exclusively in certain localities. A clarification procedure yielding juice of pH 7.0 or above was found necessary for good clarity. However, since the mud volumes are large and the high content of salts characteristic of this variety adversely affects sugar boiling under neutral or alkaline conditions, it was concluded that a procedure yielding clarified juice of pH ranging from 6.5 to 6.7 results in better average operating condition.

Comparable samples of five of the newer commercial varieties of sugarcane from six different test fields were studied with regard to their nonsugar content and the composition of their juices, in order to determine their relative sugar-making values. These included CP 28–11, CP 28–19, Co. 281, CP 29–320, and CP 29–116, the last having been released for cultivation in 1936. The crusher juice from each sample and also the whole mixed juice from each variety was analyzed for total ash, phosphates, sulphates, chlorides, potash, lime, magnesia, and silica. CP 28–11 was characterized by high ash and high sulphate content, CP 28–19 by low ash content, CP 29–116 by low ash and low lime content, and Co. 281 by high lime and high sulphate content. A number of new cane seedlings also were studied in a preliminary way. Incidental to this work, a new method was devised and used for estimating the approximate total salt content of cane juices.

Data were obtained showing that there are striking differences in the distribution of nonsugars between the nodal and internodal portions of different varieties of cane. In Co. 290 the salts are mostly soluble and concentrated in the internodes, whereas in Co. 281 the concentration is greatest in the nodes. This difference in distribution affects the extraction of salts at different stages of milling and thereby the reduction factors.

The cane varieties Co. 290, Co. 281, CP 807, and CP 28–19, as well as certain seedlings, were compared on the basis of whole cane analysis, as contrasted with the substances extracted by milling and those extracted by diffusion in water. The low nitrogen content previously found to be characteristic of the juice of variety Co. 290 was found to hold true for the whole millable cane. Analysis of the whole mill juice gives information on the quantities of phosphate and potash removed from the soil.

Studies were continued, in cooperation with the Division of Sugar Plant Investigations, Bureau of Plant Industry, on the causes and prevention of deterioration in harvested sugarcane during short-time storage. This is an important problem because, if it were possible to store sugarcane without appreciable deterioration, it would allow the operation of the sugar factory during the normal rainy periods of the harvesting season and prevent a large loss from freezing, provided the cane were stored prior to the freeze. In previous studies it had been noted that, under high humidity, a temperature between 55° and 65° F. was best for preventing deterioration, and that the rate of deterioration increased below and above these limits of temperature. In these studies 45° F. was the lowest temperature employed. In this year's studies, however, cane was stored at a minimum temperature of 36° F., and it was found that the rate of deterioration was less than at 45°, probably because of reduced physiological activity. Previous findings that storage under low humidity, which allowed loss of moisture from the cane, was conducive to loss of sucrose by inversion were substantiated.

Tests on a large number of CP seedling varieties of cane available at the Houma station, to determine their suitability for windrowing, which must frequently be resorted to in order to prevent heavy losses of the crop by freezing, revealed that several were equal or superior to Co. 281 in this respect. This knowledge is useful in the final evaluation of canes that otherwise might be suitable for commercial planting, and it indicates crosses which might be made in breeding experiments to bring out desirable characteristics in cane.

Further evidence was obtained that the inversion of sucrose in harvested sugarcane under certain conditions of storage is not proportionate to the quantity of invertase present, and that inversion is controlled by some unknown factors, other than the mere presence of invertase.

As a result of the Bureau's work on beet sugar, in cooperation with the beet-sugar industry, there has been continued progress in the quality and uniformity of this important domestic product. Objections formerly raised by consumers to the use of beet sugar for certain purposes have been largely eliminated, and this commodity should enjoy its rightful parity with cane sugar and should find greater consumption in its own territory with substantial savings in freight charges. Composite sugar samples, representative of all the beet-sugar-producing areas of the United States, were subjected to detailed analysis. There was a marked degree of uniformity in this year's production. The results are fully discussed in the annual beet-sugar report issued by the Carbohydrate Research Division.

During the year further study was made of methods for the determination of the color and turbidity of sugar solutions and of the appearance of granulated sugar by means of the Brice-Keane photoelectric reflectometer which was developed in the Department. A simplified procedure for these determinations will be described in a forthcoming publication. The Brice-Keane reflectometer is now a commercial instrument and is in use in the beet-sugar industry for the purpose of obtaining an index of the appearance and quality of the sugar produced.

The sugar arabinose was prepared from sugar-beet pulp. This sugar and xylose were used for the preparation of fondant. The results show that both arabinose and xylose can be put in the solid phase of the fondant. Arabinose has the advantage over xylose in being less soluble. A study was made of the separation of dextrose and levulose in invert-sugar preparations, on the basis of the difference in their solubility in various solvents, but an entirely suitable process has not yet been developed.

FARM-MADE SIRUPS

On many thousands of farms in the South, particularly the smaller ones, sugarcane is grown for the production of sirup instead of sugar. The crop is harvested and made into sirup late in the year when other crops have been harvested and farm labor otherwise would be idle. The quantity of sirup made on individual small farms ranges from 50 to 500 gallons a year, and the total annual production amounts to between 15 and 20 million gallons. Sugarcane for sirup is a diversification, subsistence, and small cash crop.

The Bureau's work on sugarcane sirup during the last year, designed to improve efficiency of production and quality and uniformity of product for both farm consumption and profitable sale, was in cooperation with the Department's Extension Service, the Works Progress Administration, and groups interested in community plants. These organizations and groups were given advisory assistance in the design and operation of plants and in the use of recently improved methods.

Nearly all of the sorgo sirup, about 17 million gallons of which are produced annually in the United States, is made by farmers with extremely limited facilities. Much of the sirup is of inferior quality and is sold at prices which yield little profit to the farmer. To aid in the correction of this situation, the Bureau is studying means for improving the quality and uniformity of farm-made sorgo sirup. Processes for improving the quality of farm-made sirups must be practicable and embody such features as low cost of equipment and simplicity of operation, if they are to find ready application. The malt diastase process for the prevention of jellying and consequent slow boiling or scorching and the practice of topping the stalks to the fifth internode to reduce the mineral, acid, and starch content of the juice fully meet the limitations of farm-scale sirup production. Studies conducted in cooperation with the Mississippi Agricultural Experiment Station during the year showed that further improvement in quality of sirup could be accomplished by combining these two methods. The details of these methods and descriptions of other improved practices and equipment were incorporated in Farmers' Bulletin 1791, entitled "Farm Production of Sorgo Sirup", which is in press.

Cooperative work in Mississippi on the composition of juices and quality of sirup from different sections of the stalks, in which 8 additional varieties of sorgo cane were used and about 100 samples of sirup were made, confirmed the conclusions from last year's work that the farm value and marketability of sorgo sirup can be materially improved by cutting off and discarding several joints of the stalk from the top. The discarded top joints can be well utilized as feed for livestock, and the comparatively small reduction in yield of sirup is more than compensated by the improvement in quality of the sirup and the feeding value of the discarded top sections of the stalks.

The Bureau continued to cooperate with the State extension services of Mississippi and Alabama, which demonstrated to farmers the improved methods of production of sorgo sirup developed by the Carbohydrate Research Division. In Alabama, these improvements have been incorporated in model community sirup plants where successful demonstrations were given throughout the season.

Additional master color standards for grading maple sirup were prepared for State agencies in producing areas, and these agencies in turn prepared color standards for distribution to farm producers. The object of this service is to correct lack of uniformity in quality grading and to enable farm producers to determine independently the quality of the sirup they offer for sale.

HONEY

The decline in the consumption of honey during recent years has reduced the income of beekeepers, of whom there are about 800,000 in the United States with about 5,000,000 colonies of bees. The value of the beekeeping industry resulting from cross-pollination of the blossoms of orchard, garden, and field crops is probably 10 times the value of the honey and beeswax produced. Marked curtailment in beekeeping, which might result from a continued decline in the consumption of honey, would be a serious threat to the future adequacy of insect pollination of agricultural crops. Even when bees are kept specifically for pollination in fruit orchards, profitable disposal of the honey is a vital consideration.

The development of potential industrial outlets for honey would stabilize the beekeeping industry. There is evidence that a number of industries would

like to use honey, and that the failure of some to use this product satisfactorily has resulted from a lack of knowledge concerning the composition and properties of honeys of different floral types and their relation to the requirements for particular uses. The Bureau, at the urgent request of national organizations interested in the production of honey, is working to acquire and disseminate this knowledge.

One of the most valuable properties of honey is its ability to absorb and retain moisture. This is particularly characteristic of honeys containing high proportions of levulose and colloidal organic substances. A study of the ability of honey to absorb and retain moisture in comparison with that of other saccharine liquids has led to the following conclusions: (1) Honeys of high colloid and nonsugar contents exhibit higher hygroscopicity than honeys of low colloid and nonsugar contents, (2) when crystallization occurs in honey its hygroscopicity is materially altered, (3) honeys in general are more hygroscopic than other saccharine liquids having the same moisture content, and (4) honeys of certain types used in baked goods (particularly cakes) increase the retention of moisture of these products, improve their quality, and retard staling. These observations indicate that if honeys of suitable characteristics are selected their use in baked products has definite advantages. The property of absorbing and retaining moisture, which honeys of certain types possess in such pronounced degree, may also give honeys of these types special advantages for use in industries other than baking.

The market quality of extracted honey has been greatly improved during the year through the widespread adoption of the Bureau's new method of processing, which depends on rapid filtration under conditions that insure practically perfect retention of flavor and yield a product of brilliant clarity, having very little tendency to granulate. A public-service patent (No. 2,070,171) covering this process for purifying extracted honey was issued on February 9, 1937.

STARCHES

In the United States there is an annual demand for about 300 million pounds of root starches for industrial uses. This demand is now largely supplied by importations of cassava and potato starches. By utilizing the surplus and culls from a number of starch-bearing crops grown in this country, a substantial part of this special starch market could be supplied with domestic products, with material benefit to our own agriculture. The Bureau, therefore, is giving attention to the chemistry and technology of producing and utilizing root starches.

Primary consideration has been given to the sweetpotato as a source of commercial starch and derived products, because of its suitability for cultivation over extensive agricultural areas and because there is always a large supply of culls and frequently a surplus of the crop. Continued work on sweetpotato starch during the year resulted in the discovery of a simple, cheap, and efficient method for obtaining high-grade commercial starch from sweetpotatoes. This method, which is a marked improvement over the one in previous use, was used exclusively during the 1936 operating season (October and November) at the Laurel, Miss., sweetpotato-starch plant, where 420,000 pounds of starch and 178,850 pounds of dry pulp feed were produced successfully on an industrial scale. Further study was made of the suitability of sweetpotato starch for utilization in industries, such as paper, textile, laundry, and dry cleaning, and it was concluded that sweetpotato starch is superior in certain respects to other starches used in these industries.

During the year The Chemical Foundation, Inc., maintained three fellowships, under the supervision of the Bureau, for studying the utilization of sweetpotato starch as a raw material for the production of more valuable compounds or derivatives and the sweetpotato-storage problem. The methods employed in storing sweetpotatoes for the food market are not satisfactory from the point of view of starch making because of the rapid loss of starch in addition to the high cost of handling and curing the crop. The study of storage problems resulted in the discovery of a method whereby it is possible to dehydrate sweetpotatoes at low cost and to obtain a stable product that can be converted into starch or into a flour suitable for certain industrial uses. The novel feature of this method is a chemical treatment of the sliced or ground sweetpotatoes, which causes the tissues to plasmolyze so that the juice can be pressed out much more effectively and the residue dried much more quickly and efficiently. By using the dried product, which is stable and can be stored indefinitely, sweetpotato-starch factories could operate during the entire year instead of

only 2 or 3 months in the fall. In large-scale operations, the soluble sugars in the expressed juice possibly could be converted into alcohol or feed at sufficient profit to pay the cost of dehydration.

CELLULOSE

Basic research on the chemistry of cellulose and its compounds was conducted by the Carbohydrate Research Division during the year in an investigation of the hydrolytic products of cellulose. The degradation of cellulose by methyl alcohol-hydrochloric acid was studied in a preliminary way. Identification of the soluble products has not yet been completed. They are nonreducing, optically active substances very susceptible to caramelization. Probably those obtained thus far are mixtures of the glycosides of dextrose and cellodextrines. To verify this supposition glycosides were prepared, starting with commercial dextrose which required preliminary purification. A study of the reactions of the glycosides of dextrose in comparison with those of the degradation products of cellulose under investigation is under way. Octaacetyl collobiose was prepared by acetolysis, and its hydrolysis by alcoholic potassium hydroxide and by alcoholic ammonia was studied.

MISCELLANEOUS CARBOHYDRATES

The carbohydrates found in vegetation range widely from the simplest sugars to the most highly complex polysaccharides. Because of the abundance of some carbohydrates in certain plants, these plants have become of greatest economic importance in agriculture as sources of food or industrial products. Thus, sugarcane and sugar beets are grown for their sucrose; corn and potatoes for food and as raw materials for industrial products, chiefly because of their starch content; and cotton primarily for its seed hairs which are almost pure cellulose in a form eminently suited for use in textiles. There are other plants which store inulin, instead of starch, as their reserve carbohydrate. This compound, on hydrolysis, yields levulose (fructose) in contrast to dextrose (glucose) from starch or cellulose. This and similar compounds have been studied little with regard to their suitability for use in the diet or for industrial products, and increased knowledge of the chemical identity and properties of these carbohydrates should lead to a more profitable utilization of some of the minor crops as well as of plants which could be grown as crops in agricultural diversification programs. The Carbohydrate Research Division has given attention to some of these plants and has published information concerning them in Miscellaneous Publication 237, entitled "Food Plants of the North American Indians."

Progress was made in perfecting a process for the production of levulose sirup from the inulin in chicory roots, but primary consideration was given, in the investigation of miscellaneous carbohydrates of domestic plants, to a basic study of plant hemicelluloses. Data were obtained on the effects of concentration, time, and temperature on the extraction of hemicelluloses from sugarbeet pulp with acid and alkaline solutions.

FOOD RESEARCH

CITRUS FRUIT PRODUCTS

In the Los Angeles laboratory, sections of citrus fruits, including navel oranges, tangerines, grapefruit, blood oranges, and various citrus hybrids, were packed in sirup to determine their suitability for use in salads. The filled cans were sterilized for 6 or 7 minutes in water at 195° F., while in motion. Some of the citrus hybrids had a better flavor than the Japanese canned mandarin oranges being sold in this country. It was found that canned blood oranges hold their color, and it is believed they will make a good salad material. Storage tests are still in progress.

Tangerine juice was prepared for canning by cutting the fruit in half across the sections and then pressing the halves between stainless steel rolls so adjusted as to cause minimum crushing of the peel. The juice was then screened, deaerated, and flash-pasteurized. The product contained 0.02 percent of volatile oil which gave it the characteristic tangerine flavor lacking in reamed juice. This quantity of oil may cause subsequent off-flavor, but the juice has not been stored long enough to determine whether or not this will occur.

In experiments on the cold storage of Florida orange juice in bulk, pasteurized and raw juices were stored in covered, but not airtight, 5-gallon con-

tainers at temperatures of 32° to 34° F. At intervals, plate counts of bacteria were made on the juice and tests were made of the potency of vitamin C. All samples showed the beginning of off-flavor after 6 weeks of storage, and all had fermented within 8 weeks. The pasteurized samples fermented as quickly as the raw samples. The vitamin C content showed a decrease, ranging from 19 to nearly 32 percent, in 4 weeks under the conditions of storage.

Studies on the vitamin C content of commercially deaerated and flash-pasteurized orange juice packed in glass bottles showed that there was a loss of vitamin C during storage, which amounted to about 19 percent at the end of 11 months.

A public service patent (U. S. No. 2,060,242) was obtained for a new type of deaerator which is more efficient than that used heretofore. One of these new deaerators of commercial size is under construction by a manufacturer of food machinery for use in a new cannery being built in Florida for the purpose of packing citrus juices by deaeration and flash pasteurization.

Tangerine concentrates were prepared which contained, in some instances, as high as 68 or 72 percent of total solids. When diluted with water they lacked the tangerine flavor, but the addition of an emulsion of tangerine oil improved the product to some extent.

Unsuccessful attempts were made to hydrolyze waste from the grapefruit canneries and to ferment it with selected organisms, in order to yield butyl alcohol, acetone, butyric acid, and lactic acid. Attempts to preserve grapefruit peel by brining have been unsuccessful thus far. The disposition of semi-solid wastes from grapefruit canneries has become an important problem. These wastes are crudely screened and poured into nearby lakes. Preliminary experiments have been made on the treatment and filtration of cannery wastes to render them innocuous.

With 29 canneries in Texas packing canned grapefruit juice, the chemists at the Weslaco laboratory spent a great deal of time giving advice as to the design and installation of equipment and assisting in the solution of problems arising during the operation of new plants by inexperienced canners.

Dextrose was found to be better than sucrose for use in canning tender segments of pink Marsh and Duncan grapefruit. For comparison, 1½ ounces of either dextrose or sucrose or 2½ fluid ounces of either dextrose sirup or sucrose sirup, prepared with water or juice, were added to each No. 2 can of segments. The packs prepared with 2½ fluid ounces of 50-percent dextrose sirup a can were among the best as regards appearance and flavor. Each pack showed some variation in individual cans, but all were satisfactory from the commercial point of view.

The results of storage tests on grapefruit beverage bases showed that vacuum-concentrated bases and bottlers' sirups can be stored satisfactorily for more than 2 years at temperatures below 45° F. Finished carbonated grapefruit beverage has been stored for more than 2 years at ordinary temperatures without spoilage or sufficient deterioration to render it unmerchantable.

It is interesting to note the statement in the July 1937 issue of The Canning Age that the entire citrus juice output of Texas is handled through a flash-pasteurization method. The details of this method were worked out largely by the Weslaco, Tex., and Winter Haven, Fla., laboratories of the Food Research Division of this Bureau.

DECIDUOUS FRUIT PRODUCTS

In canning investigations at the Los Angeles laboratory, Boysen dewberries were packed in 40-percent sirup in No. 2 cans of three types, namely, ordinary lacquer on coke tin plate, citrus enamel on coke tin plate, and citrus enamel on charcoal tin plate. A comparison was made of storage at room temperature and at 38° F. At the end of 11 months the pack stored at 38° had slightly better color and flavor than those stored at room temperature. The pack giving best results was one in charcoal tin-plate cans coated with citrus enamel. The fruit had been covered with 40-percent sirup, closed cold under 25 inches of vacuum, and cooked for 10 minutes at 212° F.

Examination of the 1935 pack of Young dewberries after 14 months of storage showed that no springers or swells had developed in any of the coke tin-plate cans coated with ordinary lacquer or in the charcoal tin-plate cans coated with enamel.

In the laboratory at Winter Haven, Fla., a strawberry sirup was prepared by crushing fresh cull berries, adding corn sugar and cane sugar to 64° Brix, and then filtering clear. Sodium benzoate was added as a preservative because the

sirup was not stored in sealed containers. After storage at room temperature for 1 year, the product still retained its strawberry aroma and taste. One part of this sirup diluted with 4 parts of water and carbonated at 2.5 to 3.0 volumes made a very satisfactory beverage, but during storage at 40° F. for 4 months this beverage acquired a musty flavor. Assuming a cost of $40 a ton for cull strawberries, the sirup would cost about 39 cents a gallon.

Papaya slices and pulp were canned experimentally. When processed longer than 40 minutes at 240° F. the material had a caramellike taste. Since spores of *Clostridium botulinum*, if present, probably would not be destroyed by heating at 240° for 40 minutes, it was considered advisable to give the product a decidedly acid reaction. This was accomplished by adding citric acid (0.8 g per 100 g of pulp), which gave the product a pH of 4.0. Sugar, at the rate of 15 g for every 100 g of pulp, was added to counteract the sour taste. No. 1 cans filled with the pulp were exhausted for 20 minutes at 212° F., sealed, and then processed for 45 minutes at the same temperature; others were vacuum sealed at room temperature and processed for 65 minutes at 212°. In the case of slices, a 6° Brix sugar solution having an acidity of 0.4 percent was added. After processing, the product had a pH of 4.3. Some No. 1 cans were vacuum sealed at room temperature and processed for 30 minutes at 212°; others were exhausted for 5 minutes at 212°, sealed, and processed at 212° for 30 minutes. Further work is planned in this field. One citrus cannery planned to make an experimental pack of papaya slices during the 1937 season. Analyses have been made of papaya juice and papaya seeds.

Under the supervision of the Seattle, Wash., laboratory, frozen packs were made of 147 field selections of promising seedlings and hybrids and of named varieties of strawberries, about 35 selections of blackberries, and about 50 selections of raspberries, in cooperation with representatives of the Bureau of Plant Industry and the fruit products industries department of Oregon State College at Corvallis, Oreg. In cooperation with the Western Washington Experiment Station, 12 named and 2 seedling selections of blueberries and 58 selections of raspberries, grown at the station, were packed by freezing.

At the Pullman, Wash., laboratory very satisfactory table sirups were prepared from Delicious apples of low acidity by concentration, both in the rapid evaporator and in the vacuum pan. Recovered esters were combined with the concentrated juice to give a desirable apple flavor.

In a study of the suitability of western-grown apples for the commercial production of canned apple sauce, it was found that sauce made from western varieties of apples is more yellow than that made from eastern apples. In general, western varieties are less tart than eastern varieties. By selecting the most tart varieties, adding less sugar than is customary in the East, and guarding against lowering of acidity by dilution, satisfactory sauces were made. Yellow Newtown, Grimes Golden, Esopus Spitzenberg, White Pearmain, and Northwestern Greening proved suitable for this purpose.

Six varieties of northwestern-grown peaches were studied in a preliminary way with regard to their suitability for commercial canning. It is planned to extend this work both as to varieties and methods adaptable to commercial use. The canning of freestone peaches has become of commercial importance in the Pacific Northwest, where the fruit is not picked until soft ripe when full flavor has been attained. The customary commercial method of peeling by treatment with lye cannot be used, because the texture of the soft fruit is broken down, giving a ragged appearance to the product.

A fruit-juice concentrator of radical design has been constructed and used for preparing concentrated juices from apples, pears, and cherries. This equipment consists of a steam-jacketed stainless steel tube in which the juice is heated while flowing. The tube is connected to a flash pot maintained under vacuum. The juice emerges into this pot in the form of a mixture of vapor and slightly concentrated juice. Since the sensible heat of the juice at the time of emergence is not enough to bring about sufficient concentration in one passage, the juice is recirculated until the desired concentration is reached. The vapor from the evaporation of the juice passes first to a warm condenser, where water is separated from the more volatile flavoring constituents which pass over to a second condenser maintained in an ice bath. The volatile flavoring constituents thus collected are combined with the concentrated juice.

Two methods of pasteurization have been found satisfactory for apple juice. The juice may be flash pasteurized in steam-jacketed, ribbon coils of the type developed for citrus juices or it may be pasteurized in No. 2 tins after vacuum sealing by immersing in boiling water for 6 minutes and then cooling. No cooked taste is developed by either of these methods.

24696—37——2

Apple juice was canned in 10 different types of tinned containers of various weights of plate coated with different protective enamels. Containers coated with enamels developed for beer and for wine have proved the most satisfactory. In unlacquered cans the juice bleached and formed a cloudy precipitate.

VEGETABLES AND VEGETABLE PRODUCTS

Experimental packs of frozen lima beans, spinach, kale, peas, green beans, and sweet corn prepared by the Bureau of Plant Industry, in 1934 and 1935, were examined to provide a standard for any future critical judging of such frozen products. The numbers and types of micro-organisms surviving the freezing and storage period at freezing temperatures were determined.

At the Los Angeles laboratory, several varieties of commercially grown cauliflower and broccoli were used in a study of the technology of preserving vegetables by freezing. Preliminary observations were made which may be of use to the California Agricultural Experiment Station in making selections for 1938 plantings on experimental plots. Experiments were also made on the freezing preservation of asparagus. An exhibition of material frozen at the Seattle laboratory was made at the Los Angeles laboratory in April. Peas, lima beans, snap beans, and sweet corn were shown, together with some cauliflower frozen at Los Angeles. About 30 persons were present when the cans were opened, including local ice and cold-storage men, county and State extension service representatives, women from the nutrition department of the University of California at Los Angeles, agricultural writers, cauliflower and asparagus growers, packers of vegetable juices, makers of bakers' supplies, seed growers, and local and State representatives of the Agricultural Adjustment Administration.

A mimeographed preliminary report of results obtained by the Seattle laboratory in a study of the quality of frozen vegetables as influenced by variety was prepared jointly with the representative of the Western Washington Experiment Station and with the collaboration of the Bureau of Plant Industry and the Washington Agricultural Experiment Station. This report, entitled "Vegetable Variety Trials in Relation to Freezing Preservation," gives the results of the cooperative work on the suitability of vegetable varieties grown during 1936 for freezing preservation. About 500 copies have been sent out in response to requests from canners and packers, seedsmen, distributors, and others interested in the subject.

At the Pullman, Wash., laboratory, tomato juice was prepared by deaeration and flash pasteurization with the expectation that this process would yield a product of better flavor and color and also of higher vitamin C content than that obtained by the usual commercial processes. In two instances out of three, samples of deaerated tomato juice were found to have a higher ascorbic acid (vitamin C) content than controls not deaerated. Further work is necessary to obtain consistent results and to determine conditions under which deaeration can be used to obtain a product of higher vitamin C content.

At the Weslaco, Tex., laboratory, canning experiments were made with several varieties of English peas and with string beans, whole tomatoes, and tomato juice. This work was largely of a preliminary nature but was expected to provide a basis for plans for extensive studies in 1938.

Studies on the commercial fermentation of cucumber pickles under southern climatic conditions have been continued at State College Station, Raleigh, N. C., in cooperation with the North Carolina Agricultural Experiment Station. Results obtained in experiments on the salting of vats of cucumbers indicate that low brine concentrations can be used effectively under southern climatic conditions, and that it is not necessary to use very high concentration to prevent spoilage. Extensive chemical analyses were made during the year on fresh material and salt stock. The reduction in sugar content of the brines roughly corresponded to the increase in lactic acid content during fermentation. It was found that the maximum production of acid was attained in 5 or 6 days, and that a yeast fermentation often followed after a few days. This yeast fermentation gave rise to so-called boiling of the vats. The gas given off was about 99 percent carbon dioxide.

A pack of fresh cucumber pickles was put up and pasteurized at 160° F. for 15 minutes. The pickles retained their crispness, color, and flavor. After 8 months of storage at room temperature they were still in good condition.

A number of barrels of cucumbers with added dill were salted, using various salt concentrations. Organic acids were added in different amounts to some of the barrels. The best dill pickles produced were those in which acetic acid had

been used. These experiments are being repeated, in order to determine the correct salt concentrations and acidities necessary to produce high-quality dill pickles under southern conditions.

STALING OF BAKERY PRODUCTS

It was found that staling of bread is not retarded simply by preventing the loss of moisture. Bread made with 85 percent of wheat flour and 15 percent of rye flour had better keeping quality than ordinary wheat bread, and the addition to wheat flour of soybean flour low in fat appeared to slightly retard staling of the bread. Bread and pound cake were stored at subfreezing temperatures for considerable periods with satisfactory results. Bread stored at 0° F. retained its freshness better than similar breads stored at 20° or 30° for the same length of time. Bread taken directly from the oven and placed in a metal container with a tight-fitting top was stored at 0° for 49 days. After being thawed, its qualities were similar to those of bread 1 day old. Pound cake, after having been stored at 0° for 6 days and then thawed out, seemed like fresh cake. Even after such cakes had been frozen for 30 and 69 days, they were judged equal in freshness to an unfrozen cake 1 day old.

GLUTEN BREAD

In experiments on the use of wet gluten in breadmaking, it was found that remixing of the fermented dough, just before panning, improved, to a marked degree, the grain and texture of the loaf. It was also found that soybean flour, rye flour, other flours, or combinations of other flours, could be added to the gluten to make a specialty or distinctive bread of high protein content of excellent quality. The use of wet gluten, prepared by washing most of the starch from wheat-flour dough, should make it possible to bake a very pleasing combination of high-protein, low-starch bread at only slightly higher cost than that of ordinary bread.

MINERAL CONTENT OF FOODS AND FEEDS

A study of the acid-base balance of cereals and some related food materials showed that practically all common cereals yield a slightly alkaline ash, but that all have an acid balance. Buckwheat, popularly but erroneously classed as a cereal, has a slight base balance. Jack beans, soybeans, and potatoes have a distinctly alkaline ash and a distinct base balance. The acid-base balance of foods may not only influence the acid-base equilibrium of the animal and human systems, but may also have an effect on the end products of mineral metabolism.

RANCIDITY

Further attention was given to the relation of peroxide content of vegetable oils and foods containing fats or oils to the development of rancidity. Both rancidity and the formation of peroxides were previously found to result from exposure of vegetable oils to ordinary sunlight. Irradiation of oils with light of constant intensity (from 500-watt CX Mazda tungsten filament lamps) in glass transmitting the ultraviolet rays led to the following conclusions: (1) Peroxides increase at a more uniform rate when oils are irradiated with light of constant intensity than when irradiated by sunlight; (2) when an oil which has been protected by a sextant green filter and already has developed a high peroxide value is exposed simultaneously with a fresh sample of the same oil to light from CX tungsten lamps, it will continue to develop peroxides and at the same rate as does the fresh oil; (3) the induction period of an oil which has been protected by a sextant green filter is unaffected by the peroxides which were developed during said protection and is equal to that of a fresh sample of the same oil; (4) the development of rancidity in oils that have been protected by a sextant green filter, and which have subsequently been exposed to light, proceeds independently of the peroxides that may have formed during the period of protection; and (5) peroxides which develop under a sextant green filter do not add to the susceptibility of the oil to become rancid.

The Russell-effect procedure for obtaining pseudophotographs, by exposing a sensitized film over a rancid oil, has been standardized so that consistent results are now obtainable. Tests have indicated the possibility that hydrogen peroxide is the active substance which brings about rancidity and also causes the Russell effect, and that the organic peroxides have little, if any, effect.

LOOSENING THE HULLS OF WALNUTS

It has been established that the hulls of sticktight California walnuts may be loosened by treatment with ethylene mixed with air in the ratio of 1 to 1,000 volumes for 60 hours if the nuts are sufficiently mature. Since there are appreciable losses of color of the kernels during the treatment, it is better to use temperatures up to 90° F. and finish in 60 hours than to use lower temperatures and longer time.

Owing to hot weather, the 1936 walnut crop was inferior in quality. Field sorting was recommended, in order to avoid putting sunburned nuts through the ethylene process. This practice, in conjunction with the ethylene treatment, raised the price received by growers in the interior districts about 4 cents a pound in a year when nuts were of less than average quality.

ENZYME INVESTIGATIONS

The isolation of the papainlike proteinase which is present in wheat flour already has been reported. This enzyme has an unfavorable effect in the process of commercial breadmaking from normal flours, but it is of advantage when abnormally hard flours are used. Its protein-digesting action is inhibited by the common bleaching agents used in the manufacture of flour. During the year, further attention was given to the activators of this enzyme. It was found that minute traces of cysteine or glutathione were sufficient to produce a desirable softening effect on dough made from hard flour. Cysteine, in quantities of 0.1 to 0.5 percent, disperses wheat gluten completely. The product is a stable protein solution that looks like milk. The properties of this protein preparation are so curious that it was studied carefully and the results published. The dispersion of the protein is believed to be due to a chemical change, namely, the reduction of the sulphide groups in gluten. Practical use of the liquefied protein as an adhesive or as the base for a plastic material seems to be possible. Since the protein coagulates in the presence of electrolytes, its use in the fining of wines and other clarification processes is being investigated.

A study was made of the occurrence of fat-splitting enzymes in flour, because of their obvious connection with deterioration of flour in storage, such as increased acidity or rancidity. It was found that flour contains little or no enzyme material capable of hydrolyzing the ordinary fats. It does, however, contain an enzyme which easily splits the glyceryl esters of some of the lower fatty acids. Any lipolytic activity in flour must, therefore, lead largely to the production of volatile fatty acids. It was observed that, on the addition of the proper substrates, these volatile acids are produced very rapidly in the cold (just above freezing) as well as at higher temperatures. Cold storage of flour cannot prevent this type of deterioration.

The Food Research Division collaborated with the Hawaii Agricultural Experiment Station in a study of methods for extracting papain from papaya fruits and plants and bromelin from low-grade pineapple juice.

EGGS AND EGG PRODUCTS

During the year a large-scale egg-oiling experiment was started at Omaha, Nebr., by a cold-storage company, in which 800 cases of eggs were divided and treated by three representative methods of oiling, including that developed by the Bureau. One-half of each lot was then shipped to New York, to determine the effect of transportation on the preservation of quality; the other half remained at Omaha in cold storage. It is estimated that 35,000 cases of eggs were treated by the Bureau's improved oiling process in 1936. A machine for applying this process commercially is being constructed by a private concern.

The Bureau's enzymic process for preparing egg whites for drying has been further developed. Three public-service patents (U. S. Nos. 2,054,213, 2,062,387, and 2,073,411) have been granted. Experiments were made to determine the value of proteolytic enzymes, other than trypsin, as thinning agents for egg white. Pepsin was used successfully to recover egg white from the foam, formerly wasted, which forms on the surface. There was some indication that papain could be substituted for trypsin. Incidentally, papain was found to have some unusual properties, notably a peculiar behavior in clotting milk. Even with excess activator present, milk appears to have the ability to render some of the enzymes inactive.

Attention is being given to methods for removing carbohydrate compounds, particularly glucosamine, which are present in dried egg white prepared by the Bureau's process and cause gradual darkening of the product, if it is not kept cool.

DRESSED POULTRY

In order to determine what chemical changes take place in the tissues of frozen poultry during storage, many chemical analyses were made on frozen chickens which had been stored for 3 years, and compared with results obtained on freshly killed poultry. With the exception of an increase in muscle glucose and in acidity of the fat, no marked changes resulting from storage were indicated by the data. Undrawn birds showed a greater increase in acidity of fat, whereas it appeared that increase in muscle glucose was greater in drawn birds. The development of acidity in the fat, due to the action of lipase, increases with time of storage and appears to be less influenced by differences in temperature than by prior treatment of the birds. The development of muscle glucose, presumably due to hydrolysis of glycogen, appears to be greater at the higher temperatures of storage.

ENZYME ACTION AT LOW TEMPERATURES

Fundamental research on the chemistry of enzymes and of enzyme action at low temperatures was carried on during the year as a project under the Bankhead-Jones Act of June 29, 1935, providing for basic research in agriculture. Five pure enzymes of the proteinase class were prepared, and their action on known proteins (casein and crystalline egg albumin) at low temperatures was studied. The enzymes, themselves, were found to be uninjured when frozen in solution and kept at —183° C. for 2 days. The activity of these enzymes on proteins followed approximately the usual course of chemical reactions at lower temperatures until the medium became solid. The change of the system from liquid to solid reduced the activity of the enzyme at once to about one-half. Glycerin, which was added to the enzyme substrate to keep it liquid and allow observations below the freezing point of water, appeared to inhibit proteinase activity to a much higher degree at low than at high temperatures, which indicates that a preservative which is useless at high temperatures may be quite efficient in cold storage.

Low temperatures had a greater effect on the clotting action of enzymes than on the well-recognized protein-splitting action. Clotting is inhibited to such a degree by low temperatures that there seems to be little likelihood of any such action occurring under cold-storage conditions.

Protein splitting is definite but extremely slow at low temperatures. The proteinases are definitely not responsible for all the changes in the quality of frozen meats, because it was found that the activities of fat-splitting enzymes are less reduced by low temperatures than are those of protein-digesting enzymes.

The effect of temperature on changes in the digestibility of fats was studied in detail. At high temperatures the velocity of hydrolysis of saturated triglycerides varies directly with the number of carbon atoms in the fatty acid, reaching a maximum at 8 or 9 carbon atoms. At low temperatures the rate of splitting is greatest for fats of the lower acids in the saturated series and for fats of the unsaturated acids, such as oleic. The rapidity with which cream and butter deteriorate in storage obviously is due to the presence of fats of the lower acids, such as tributyrin. The hydrolysis of this fat at low temperatures was found to occur with unusual rapidity.

In order to gain information which will be more applicable to natural fats, research is being undertaken on the behavior of mixed glycerides toward fat-splitting enzymes at low temperatures. This will require a great amount of work in synthetic organic chemistry for the preparation of samples.

The results of the work on the action of enzymes at low temperatures are given in three papers which have been prepared for publication.

WAXLIKE COATINGS OF FRUITS

Research was continued during the year on the chemical composition of waxlike plant products, particularly those on the surface of fruits. It has long been known that the surface coating of fruits retards evaporation of water, regulates the exchange of gases between the internal and external atmospheres, and provides, so long as it remains intact, protection against invasion by bac-

teria, fungi, and, to some extent, insects. More recently it has been learned that the waxy substances of the cuticle are of prime importance in the application and subsequent removal of insecticidal sprays. Much effort has been expended by research workers and in commercial developments toward devising methods of making sprays spread over and adhere to the waxy surface of fruits, and of removing from the harvested fruit spray residues which have been encompassed by further deposits of natural wax. Since these waxy constituents occur in many waste products from the canning and preserving industry, a knowledge of their character and means for their recovery may lead to industrial uses, some of which have already been suggested.

During the year investigations were completed on the nonvolatile waxy residue remaining after distillation of Florida grapefruit-peel oil. This material was found to contain solid fatty acids (dotriacontanoic, linolenic, linoleic, and oleic), a sapogenic ketone of high melting point, the hydrocarbons nonocosane and hentriacontane, a phytosterol, and umbelliferon. Laboratory work was also completed on the identification of constituents in the waxlike coating of the Bing cherry. Palmitic, stearic, linoleic, and oleic acids were isolated from the saponifiable, and nonocosane from the unsaponifiable, fraction of the wax. Glycerol, the sapogenin ursolic acid, and d-glycosidyl-sitosterol were also found in the cherry wax. The quantity of waxy material on Bing cherries is rather low, the petroleum ether and ethyl ether extracts being only 0.8 and 0.1 percent, respectively, of the dried skins. A comparison of these figures with the corresponding percentage yields from apple and pear cuticles indicates that herein lies the explanation for the less efficient protective surface coating of the cherry.

FRUIT SKINS

All fruits and vegetables are enclosed by a heterogeneous membrane designated by botanists as the cuticle. This cuticle, commonly called skin, plays an important role in the life of the plant during growth and continues to do so until the plant or any particular plant organ is disintegrated by decay or other destructive processes. If the cuticle is separated from adjacent tissues and then extracted with ether, it may be divided into two main parts, the ether-soluble fraction or waxlike coating, and the ether-insoluble part, which is often referred to as "cutin." Knowledge concerning the chemical nature of cutin is rather meager, but it is expected that investigations now under way will prove it to be an esterlike substance which, on saponification, yields a number of solid and semiliquid acids. Attempts are being made to identify these products, in order to have definite knowledge concerning the chemical structure of cutin. Apple cutin, after being subjected to preliminary treatment for the removal of foreign matter, with the exception of a small percentage of cellulose, was saponified with alcoholic potash, and an attempt was made to separate the products so formed. Two main fractions thus far have been obtained, one an oily substance and the other consisting of one or more solid acids. Ordinary methods have so far failed to separate the solid acids, but molecular distillation of the acid esters offers some promise of accomplishing their purification.

APPLE PIGMENTS

The development of color in apples is important, both to the grower and the consumer. Well-colored apples almost invariably command higher prices, and they are the least susceptible to storage scald. The maximum development of color is, moreover, a criterion of that particular stage of maturity at which the fruit will attain satisfactory flavor and aroma and also be most edible in other respects. Owing to the economic value which is placed on color in apples, attempts have been made to determine the factors which are responsible for and influence the production of color. Before there can be a more thorough understanding of the complex subject of pigmentation in apples, however, it is necessary to acquire knowledge of the chemical nature of the pigments involved and of the biochemical reactions responsible for the formation of the red, or anthocyanin, pigment and of its chromogenic precursor. The results of an investigation on the coloring matter of Grimes Golden, Jonathan, and Stayman Winesap apples have been published. The anthocyanin pigment of Jonathan and Stayman Winesap apples was identified as idaein, a galactoside of cyanidin. The yellow pigment of Grimes Golden and Jonathan apples, which is soluble in the cell sap, has been identified as a previously unreported galactoside of quercetin. It may safely be assumed that the red pigment occurs in all red apples, and that the yellow pigment occurs in both red and yellow fruit. As

previously observed with the pigments of corn husks, the anthocyanin, or red, pigment is the reduction product of the yellow pigment. Red apples obviously possess the complete mechanism for converting the quercetin galactoside or chromogen into red idaein. In apples of the Grimes Golden type apparently there is lacking or inhibited some factor other than the chromogenic substance, since the latter is present but not capable of being reduced to its homologous anthocyanin.

PLANT VIRUSES

In cooperation with the Bureau of Plant Industry on a Bankhead-Jones project for the study of plant viruses, the Bureau is making studies on their character and properties.

Quantities of the crystalline protein known as the virus of green tobacco mosaic were prepared by the method recently published by W. M. Stanley. It was found possible to shorten this procedure and produce crystals which were as infectious as those prepared by the longer method from comparatively crude tobacco protein after digestion with trypsin.

On several occasions modifications of Stanley's method resulted in the production of protein crystals which differed decidedly from the ordinary form. Such atypical crystals were found to be infectious, but their real significance and importance has not yet been determined. It is probable that they represent merely a second crystal form of the same substance.

Further work on the tobacco mosaic consisted of a comparison of the enzyme systems of normal and infected plants.

In experiments on the respiratory rate and respiratory quotient of mosaic and healthy tobacco tissue, it was found that the respiratory rate varied widely with the age of leaf chosen. No significant differences could be established between comparable leaves of healthy and diseased plants.

From studies of the amylase content of tobacco leaves, not yet completed, it appears that infection with yellow mosaic results in an increase in alpha amylase, whereas infection with green mosaic does not.

Efforts are being made to find a clue to the action of the virus in the plant and a means for measuring the potency of the virus by a chemical determination rather than by a plant assay.

MINERAL CONSTITUENTS OF PLANTS

Toward the close of the year, work was started on a new project which has for its object the collection of all available information relating to the effects of soil mineral constituents on the mineral content of food plants and the effects of plant mineral constituents on animal and human nutrition. This work is being done in connection with the Department's program of basic research in agriculture, provided for in the Bankhead-Jones Act of June 29, 1935, to determine the need for possible cooperative research on this subject. It involves a thorough search of chemical literature and also the collection of the very extensive unpublished results of the State agricultural experiment stations which are giving their cooperative assistance through careful attention to a questionnaire.

TOXICITY OF INSECTICIDES TO HIGHER ANIMALS

During the year extensive building alterations were made at Stanford University, Calif., in order to provide adequate space and facilities for the Bureau's cooperative pharmacological studies on foods. These studies are concerned with the acute and chronic, but chiefly the chronic, intoxications which may result from the consumption of food and food products contaminated with insecticidal-spray residues, food preservatives, and metals which may occur naturally in foods or as the result of canning and cooking processes.

Investigations were made on the isolation and identification of the compounds excreted in the urine, and on the relationship of hydrogen-ion concentration, oxygen consumption, and the bactericidal properties of the urine, following the oral administration of phenothiazine. Toxicity studies on methyl and lauryl thiocyanate and on anabasine have been completed. The toxicity of thiocoumarin, paranitrobenzene, derris, and pyrethrum also received attention. Experiments were made on the production of anemia in rats by feeding diets containing fluorine, in the form of cryolites, and on the production of exostosis of the bones in rabbits by repeated injections of sodium fluoride.

Experiments on the continued feeding of dicalcium phosphate containing from 0.25 to 0.27 percent of fluorine to albino rats showed that the presence of large

quantities of calcium and phosphoric acid does not reduce or antagonize the toxicity of fluorine. The toxicity of fluorine, present as a contaminant in dicalcium phosphate, is as great as that of sodium fluoride.

Three papers were published as a result of the studies on chronic toxicity of nicotine. The chronic effects of nicotine, resulting from continued feeding of nicotine-containing diets, can be accounted for very largely by the decreased food intake, which of itself would cause stunted growth. Data have been obtained on the organ weights of rats used in the experiments, but the significance of changes in organ weights cannot be evaluated until data are accumulated showing the relation of organ weights to food intake. Experiments to supply these data have been started.

As in the case of nicotine, the changes in growth rates, resulting from continued feeding of anabasine, can be largely accounted for by the lowered food intake.

INDUSTRIAL FARM PRODUCTS RESEARCH

The Industrial Farm Products Research Division concerns itself with the utilization of agricultural products for nonfood purposes from three angles, namely, (1) improvements in the raw materials and in processes now employing agricultural products, (2) new and more extended uses for agricultural products already employed in industry, and (3) new uses for agricultural products now considered useless for industrial purposes. The following statements regarding work in the various sections of the division are intended to show what progress has been made in these directions during the year.

HIDES AND SKINS

The results of extensive observations in an almost virgin field of research, namely, the influence of animal feeding on the leathermaking characteristics of the skins, have been assembled and approved for publication. These studies yielded data of special value because of their fundamental and quantitative correlation of life factors with the characteristics of the animal skin. Nine sets of twin lambs were used in the feeding experiments. The twins were divided into two groups, one of which was full-fed and the other underfed. The final average body weight of the underfed lambs was 56 percent of the weight of their full-fed twin brothers. Based on natural thickness, leather from the skins from the underfed group had a tear resistance equal to 54 percent of that of the leather from the full-fed animals, a tensile strength equal to 60 percent, and stretch at break load equal to 81 percent. The skins and leather from the full-fed animals had distinctly larger collagen fibers with a high angle of weave, a more open fiber structure, and a much higher grain, the latter being dependent on the relative development of skin fibers and wool fibers during growth.

The results of these studies on lambskins, showing the influence of feeding, have aroused keen interest in the trade among both the scientific men and the tanners. This is especially true of the tanners of calfskins, who have urged that similar studies be undertaken with calves at the first opportunity. Toward this end and for fostering a broader and more effective program of research on the influence of animal-life factors on the leathermaking characteristics and value of hides and skins, a formal cooperative agreement has been entered into with the Bureau of Animal Industry.

The observations and data obtained from previously described experiments on the curing of calfskins with salt plus small quantities of special chemicals have been published. Aside from showing specifically the effectiveness of the chemicals used, this work has demonstrated the economic possibilities in developing methods of curing that will stop the action of bacteria and molds on hides and skins. In a continuation of these studies, other chemicals mixed with salt have been tried out on a small scale, but so far no treatment has been found that appears more promising than the mixture of salt, sodium silicofluoride, and paranitrophenol used in previous experiments.

Small-scale laboratory experiments have been made on the effectiveness of various denaturants mixed with salt for the resalting of hides and skins. Since only 3 or 4 pounds of very fine salt are sufficient to obtain a uniform distribution of salt over the flesh side of about 60 pounds of salted calfskin, it was deemed necessary to increase the ratio of denaturant to salt over that found effective for salting green hides. A mixture containing sodium silicofluoride and paranitrophenol appeared distinctly the most effective of the four mixtures tried. All four, however, showed better preservation than with salt alone.

In connection with the addition of fluorides to salt for curing calfskins, consideration was given to the possibility of introducing fluorine into gelatin made from them. The fluorine content of commercial gelatins is from 4 to 10 parts per million. Experimental gelatins made in the laboratory from calfskins cured with salt alone were found to have about the same fluorine content. The fluorine content of gelatins made from calfskins cured with salt to which fluorides had been added was found to be materially influenced by the manner of washing the skin prior to liming. With thorough washing in running water these gelatins had about the same fluorine content as the gelatin from calfskins cured with salt alone, but when washed by still soaking a high fluorine content resulted. Impurities in commercial salt capable of forming difficultly soluble fluorides may markedly influence the fluorine content of gelatin made from calfskins cured with salt plus fluorides.

Both naphthalene and paradichlorobenzene have been used commercially for preserving salted hides and skins. Studies on the toxicity of these chemicals in the vapor phase to fungi isolated from salted hides indicated that the vapors of these chemicals are not fungicidal but do inhibit the growth of mold. It was found that fats, which are always present in hides and skins, will absorb enough of the vapors to materially prolong inhibition of the growth of mold.

Continuation of studies on the physiology of hide-reddening organisms has established that these organisms when producing red pigmentation cause an oxidative type of break-down in protein substrates. These same organisms, when grown on media of low salt content, do so by a reduction of protogenous substrates without the formation of reddening or pigmentation.

A long-time semicommercial experiment planned to observe the keeping quality of salted calfskins in cold storage over a period of at least 4 years is under way. Each skin was divided into two sides to be held in storage for different periods. One-half of the first lot of calfskin sides was tanned into finished leather a year ago. The second half of this same lot is now being tanned in the same tannery and by the same processes. The sides in the second half were 31 months old when put to soak and had been in cold storage 26 months. From all outward signs they appeared to be in excellent condition. When tanned, these sides will be mated with their respective opposite sides from the same skins, which were processed 1 year ago. The sides will be selected, graded, tested, analyzed, and otherwise directly compared with each other, for determination of the deterioration, if any, resulting from additional cold storing for 1 year. The tanning of one-half of the sides of the second lot has been started for comparison with mate sides to be taken from cold storage 1 year hence.

TANNING MATERIALS

The leather industry of the United States consumes annually about 115,000 tons of tannin, equivalent to 460,000 tons of 25-percent extract. It imports practically half the tannin it consumes. Two-thirds of its total consumption comes from two raw materials, namely, chestnut wood and quebracho wood.

Tannins are used to make vegetable-tanned leathers, especially heavy leathers, such as sole, belting, harness, case, bag, and strap.

One of the most comprehensive surveys and studies ever made of a tanning material has been published in Department of Agriculture Technical Bulletin No. 566, entitled "Western Hemlock Bark an Important Potential Tanning Material." This study was made to gather and present facts on which those who might be interested could base a decision as to the feasibility of salvaging waste hemlock bark of the Pacific coast region in the form of tanning extracts for making leather.

It is shown that western hemlock bark yields a high-grade extract capable of making satisfactory leather when used alone or blended with other tanning materials. About 5.5 tons of the bark will yield 1 ton of powdered extract containing about 55 percent of tannin and having a market value ranging from $88 to $110 a ton. This would give a value for the waste bark ranging from $5.50 to $8 a ton. It is probable that the extract, after it has been introduced, would bring about 8 cents a tannin unit in the eastern markets. Until the merits of the extract have been established, however, this price will meet with serious sales resistance.

It is estimated that, with present operations, in Washington and Oregon there are available annually for making into tanning extract at least 50,000 tons of western hemlock bark. By modification of logging practices, the supply

probably could be increased to 260,000 tons of bark having a potential value in the form of tanning extracts of over $3,000,000 annually.

A formal relationship has been established with the Bureau of Plant Industry for a program of research covering tannin-bearing plants and their development, preferably in the form of new crops. One of the first steps, which is now under way, is a review and analysis of available information to select those plants offering the most promise of successful development.

Some interesting data on tannin content have been obtained from a special collection of samples of *Lespedeza sericea* from the Bureau of Plant Industry. *L. sericea* is an Asiatic legume introduced into this country as a hay-grazing crop, especially for the Southeastern States. The collection comprised 20 samples of separated leaves and stems cut at weekly intervals from May 29 to July 31, 1935, from experimental plots at the Arlington (Va.) Experiment Farm. The tannin content of the leaves, by the hide-powder method of the American Leather Chemists' Association, increased steadily from 7.5 percent in the youngest cutting to 17.1 percent in the oldest. Most of the tannin is in the leaf of the plant, the tannin content of stems being just a little over 1 percent. On the basis of these results, lespedeza should be cut for hay as early as possible. Even then the tannin content may be high and in later cuttings may be great enough to seriously interfere with assimilation by livestock.

LEATHER

Strictly comparable studies with laboratory-tanned leathers have shown that incorporation within vegetable-tanned leather of sodium chloride or sodium tartrate, 2.5 and 5 percent, respectively, imparts high resistance to acid rot. Although both salts are very effective, sodium chloride is preferable because it is cheap, practically neutral, and needs no adjusting of the pH value of its solutions when applied. Furthermore, sodium chloride, unlike alkali salts of weak organic acids, does not increase the absorption by the leather of acids from the atmosphere. In equal quantities it affords greater protection than sodium tartrate and would appear to do so over a longer period of time.

The results of these studies, which have been published, have raised an especially fundamental question as to why and how sodium chloride acts as a protective agent in retarding the acid rot or red rot of leather. As a result of this work two tanners have reported that they are now putting sodium chloride into bookbinding, upholstery, and similar leathers.

In cooperative studies with the Government Printing Office on bookbinding leathers, a chrome-tanned sheepskin, the first leather of this type ever purchased by the Printing Office for bindery work, was tested for permanence. On exposure to accelerated rotting in the gas chamber this leather lost, after 12 weeks, only 11 percent of its strength, and after 18 weeks, 16 percent, indicating exceptional permanence. This is especially noteworthy, as the leather was made from sheepskin which ordinarily has a low rating for permanence. These results suggest a means of utilizing sheepskin for binding and similar purposes, where permanence is a dominating element. Tanners of sheepskins should recognize this possibility and should show a more progressive interest in it.

Previous work has shown that combination vegetable-chrome retanned leathers are more permanent than straight vegetable-tanned leathers. Data that have been acquired on commercially made combination leathers, however, show that all leathers of this general tannage do not have essentially the same resistance to decay. In fact, some of them show but little more resistance than straight vegetable-tanned leathers. Apparently there are unknown factors involved in the making of leathers of this character that exert a pronounced influence on their performance, one of which may be the chromic oxide content. Consequently, an elaborate set of laboratory-tanned combination leathers and straight vegetable-tanned leathers was made. In this set the combination-tanned leathers included a range in chromic oxide content from about 0.5 to 3 percent. These leathers have been exposed to accelerated aging, tested, and analyzed. The data are being assembled for publication. Although definite conclusions are as yet premature, the indications are that the resistance to decay of the combination vegetable-chrome tanned leathers is not proportionate to the chromic oxide content.

For a number of years the research work by this Bureau on the causes and prevention of the rotting of leather by acids absorbed from the air has been promoted by the use of a gas chamber for accelerated rotting. The value of such an apparatus in obtaining results within several months rather than after

many years has now been definitely demonstrated. As a result a number of tannery chemists have voiced the desirability and usefulness of a standardized gas chamber, not only for the study of the effect of changes in their own particular processes, but also for comparative work between different laboratories. The present gas chamber depends for its corrosive atmosphere on the burning of city illuminating gas. This obviously varies greatly throughout the country. In response to the expressed need of such equipment, much attention has been given to the development of a duplicable gas chamber. Decided progress has been made in designing and building an apparatus of this type. When it is completed, data on its performance will be acquired for publication, together with a description of the chamber.

Through committee memberships cooperation has been continued with the American Leather Chemists' Association in research work on leather, and with the Federal Specifications Executive Committee in the drafting and revising of specifications for leather and leather goods to meet the requirements of the Federal Government.

FARM FABRICS

During the year experiments were continued to determine the effectiveness of copper compounds as mildew-proofing agents for cotton fabrics, particularly when used as constituents of mixtures for the mineral dyeing of cotton duck. A manuscript giving the results of this investigation has been prepared for publication, which will close the project.

UTILIZATION OF FARM WASTES

In the Agricultural Byproducts Laboratory at Ames, Iowa, small--scale destructive distillations were made on almond shells, bagasse, flax shives, rice hulls, grape pomace, olive pits, and date seeds, using a closely controlled electrically heated retort. Analyses of the destructive-distillation products from these materials were completed and the data compiled. The results of this work are being correlated and assembled in a general report on the destructive distillation of farm wastes.

A new cellulose laboratory has been established and equipped with the necessary experimental apparatus for small-scale pulping and bleaching, alpha-cellulose production, and viscosity work on cellulose. A constant-temperature humidity room has been built for conditioning pulp and paper samples before testing. Samples of commercial pulps have been collected from manufacturers as standards of comparison in the production of paper pulp from the cellulose fibers in crop residues. Investigation is under way to ascertain the effect on pulping action of adding inorganic salts to pulping liquors. Coordination of bleaching methods has been started, both at Ames and in Washington.

The practicability of nitric acid as a pulping agent for sugarcane bagasse or other residues depends on reuse of the liquor. Fortunately, used nitric acid liquor has been found to be a better pulping agent than pure nitric acid. Investigations have shown that acetic, formic, and oxalic acids are formed when dilute nitric acid acts on lignocellulose material, and these have a beneficial effect. Preliminary work has been started in glass with alcoholic nitric acid with promising results. Small-scale nitric acid pulping experiments have been made on both straw and bagasse. Equipment made of special acid-resistant alloy has been designed and ordered for pilot-plant-scale experiments.

The success of any pulping process depends on efficient utilization of pulping agent and the recovery of chemicals from the spent liquor. This is especially true in the pulping of bulky crop residues, due to the large volume of dilute solution necessary to cover the material and the large quantity of chemicals required. For the purpose of determining the degree of consumption of chemicals in the pulping process, a cheap, compact, and accurate instrument has been devised, which quickly gives direct readings of electrical conductivity of solutions by adjusting a slide-wire rheostat. This instrument may be used with the ordinary 110-volt, 60-cycle, alternating current. With its aid the different degrees of "spentness" of caustic soda solutions, or the consumption of caustic in the formation of sodium carbonate and organic sodium salts, may be closely followed. It has been used for determining the direct-causticizing effect when lime is added to spent liquor. The results, which are being prepared for publication, show that the direct-causticizing treatment is effective and practical.

LIGNIN

The lignin compounds or complexes obtained as byproducts of pulp making have proved useful for treating natural water supplies to remove iron and manganese and to reduce the quantity of fluorine present. They compare very favorably with commercial products sold for these purposes. An application for a public-service patent covering this use of lignin complexes has been filed. Treatment of water containing carbon dioxide with lignin and some lignin complexes releases the gas from solution so that it can be removed easily. Removal of carbon dioxide is very desirable in the instance of boiler feed waters, and lignin may eventually be used in large volume for this purpose.

The results of the study on ammoniation of waste sulphite liquor for fertilizer use, previously reported, have been published.

A study was made on the chemistry of lignin from oat straw and rice straw. In connection with this work it was necessary to develop a new analytical procedure for determining percentages of methoxyl and ethoxyl when both of these groups are present.

The nature of the complicated chemical reactions by which lignin is synthesized in the living plant is also under investigation. The oat plant was selected for this study, samples being taken at weekly intervals from the time the seedlings emerged from the ground until maturity.

Some work has been done on the dehydrogenation of lignin from corncobs with selenium and on the chlorination of lignin.

FERMENTATION PRODUCTS

Experiments were made with cornstalks, in order to determine the break-down into gaseous products caused by the bacterial flora which may be present in the material. Various controlled temperatures and periods of time were used. Complete analytical data on starting material and products of reaction have been compiled. Similar experiments were made with wheat straw, flax straw, Jerusalem-artichoke tops, and spent cook liquor from the manufacture of wallboard. It was found that the chemical composition of the material, as indicated by determinations of lignin, cellulose, and pentosans, was not a dependable criterion for predicting the results of anaerobic fermentation. Apparently physical factors play an important role. A report on the effect of temperature of digestion on the production of fuel gas from farm wastes has been submitted for publication.

For pilot-plant-scale experiments on the production of organic acids by mold fermentation of corn sugar, a 400-gallon aluminum rotary fermenter, together with accessory equipment, was installed in the Agricultural Byproducts Laboratory at Ames, Iowa. Experimental work with this equipment has demonstrated that the mold fermentation processes previously developed in the laboratory can be carried out on the larger scale without loss in efficiency or ease of operation. This equipment has aroused a great deal of interest, and a number of commercial firms have requested permission to make use of the principle underlying its design.

Up to the present, the large rotary fermenter has been used only in the manufacture of calcium gluconate, of which over 1,000 pounds were made from corn sugar. Results have indicated that calcium gluconate can be made more cheaply by this method than by any other known. Experiments with the small rotary fermenter have shown that it is possible to use this same type of equipment in the production of a pure dextrolactic acid from corn sugar and the oxidation of sorbitol to sorbose. Both processes will be tried in the semiplant-scale fermenter when the small-scale experimental work has been completed.

POWER ALCOHOL

Preliminary to investigations on the production of power alcohol from agricultural products, a general survey has been made of the problem. This work was undertaken because of the increasing consumption of motor fuel with a consequent decrease in irreplaceable petroleum reserves, the existence of farm surpluses and wastes which might be processed for use as fuel, the popular interest and growing industrial development in the production of ethyl alcohol from saccharine and starchy plant products for specific use as motor fuel, the increasing interest in the possibility of producing farm crops specifically as raw materials for industry, and the need for sources of power for farm use, which could be produced on the farm.

The chief activities during the year have been the making of contacts with Government agencies, equipment manufacturers, and producers of products suitable for fuel; the collection of statistics on the production of fuels now used and of possible raw materials including crop surpluses, culls, and wastes; the study of possible processes and plant designs for the production of fuels from agricultural materials; the establishment of patent and literature files on the subject; the inspection of alcohol plants; and similar work necessary for a general survey of the problem. A report has been prepared summarizing tentative findings to date.

CHEMICAL CONVERSION OF OILS, FATS, AND WAXES

During the year the Bureau entered on a comprehensive program of research, the purpose of which is to convert agricultural oils, fats, and waxes into new products useful in industry. The ultimate products are expected to include plastics, wetting agents and other textile and leather-finishing assistants, pharmaceuticals, soaps, dyestuffs, germicides, lubricants, synthetic waxes, and rubberlike compounds. Preliminary work has been done on the preparation of amino derivatives of fatty acids which may find use in the compounding of rubber.

INDUSTRIAL UTILIZATION OF SOYBEANS

The Regional Soybean Industrial Products Laboratory was established toward the close of the fiscal year 1936 in quarters furnished by the University of Illinois at Urbana. Its purpose is to conduct research, in cooperation with the Bureau of Plant Industry and the agricultural experiment stations of the North Central States, on soybeans and soybean products designed to promote their industrial utilization. The work at this laboratory is part of the Department's program of basic research in agriculture, provided for in the Bankhead-Jones Act of June 29, 1935. It includes analyses of soybeans and soybean products as an aid to the agronomic and technological research, studies on the properties and industrial utilization of soybean-oil meal and soybean oil and their constituents, including proteins, carbohydrates, glycerides, fatty acids, phosphatides, sterols, and associated compounds, and studies of the engineering and economic aspects of the industrial utilization of soybeans and soybean products.

Active work in most of these lines has been in progress during the year, although there were some delays caused by the necessity for designing and procuring special equipment and of making preliminary studies.

Analyses have been completed on 166 samples of soybeans representing 9 different varieties. Thirteen separate determinations were made in the analysis of 77 of these samples, and 8 determinations were made on each of the others. Although the samples analyzed represent only a fraction of the total experimental plantings in 1936, some very interesting indications have been noted. All varieties grown at Ames, Iowa, gave a uniformly high yield of protein, and the oil possessed a high iodine number. On the other hand, varieties grown at Columbia, Mo., showed a definite trend toward the formation of oil having an abnormally low iodine number.

For studying the chemistry of the fatty acids and the composition of the glycerides of soybean oil, a sample of oil was prepared carefully from a bushel of beans of known variety and history. The usual constants have been determined, and the fatty acid constituents are now being determined in detail.

Crude sterol mixtures were separated from soybean-expeller oil and subjected to various purification processes to remove nonsterol components. Attempts to isolate and identify stigmasterol, which is of great value in the synthesis of sex hormones, have been unsuccessful thus far. A sterol glycoside has been isolated in pure form, but neither the sterol nor the sugar component has been definitely identified.

In connection with studies on the possibility of improving the stability of edible soybean oil, experiments were carried out which established the fact that trimethylamine oxide, a break-down product of lecithin, reacts with oleic, linoleic, and linolenic acid esters to yield various substituted amines and unidentified products and that the fatty acid esters, especially the linolenic ester, acquire odor characteristics which closely resemble those of a so-called badly reverted soybean oil.

Quick-drying varnishes of pleasing appearance were made from blown and heat-bodied soybean oils, in combination with various synthetic resins. Attempts were made to improve the drying quality of soybean oil for use in paints by treatment with various driers. Although some success was attained, a definitely

satisfactory drier for use in soybean oil paints has not been found. Panels coated with soybean varnishes and paints have been prepared and placed on racks for weather-exposure tests.

Some preliminary work has been done on the preparation of paper coatings from protein material extracted from soybean-oil meal by water and by weak alkali. These protein extracts have been found to vary in dispersibility and viscosity, and possible causes of these variations are being investigated.

CHEMICAL WEED KILLERS

In collaboration with the Bureau of Plant Industry, a semi-industrial scale electrolytic sodium chlorate plant was successfully operated, and about 7,000 pounds of this herbicide were made and shipped to agricultural experiment stations, designated by the Bureau of Plant Industry, for use in field studies on the control of noxious weeds. From economic studies it was concluded that sodium chlorate can be produced at 4.9 cents a pound. This figure excludes sales and promotion costs and corporation taxes, but includes 5 percent interest on investment. At present, the base selling price in carlots from the sole American producer is 6.25 cents a pound. The farmer pays from 9 to 10 cents a pound for small purchases. A report on the cost of manufacturing sodium chlorate, based on this investigation, has been submitted to the House Appropriations Committee of Congress and will be published in abbreviated form.

In collaboration with the Bureau of Plant Industry, a new herbicide has been developed. It comprises nitric acid mixed with a dehydrating mineral acid, such as phosphoric or sulphuric acid. The presence of oxides of nitrogen or copper salts in these acids appears to be advantageous.

NAVAL STORES RESEARCH

CHEMISTRY OF NAVAL STORES (TURPENTINE AND ROSIN)

In connection with experiments on the dehydrogenation of fractionated rosin products from pine gum it was noted that palladium carbon, normally a dehydrogenating catalyst, also brought about an isomerization of the resin acids and that the resulting products were essentially pyroabietic acids which are comparable in stability with devtropirmaric acid, one of the most stable of the known resin acids. The high stability of pyroabietic acids, both as regards isomerization and oxidation, renders them superior to abietic acid or any of the mixed acids present in rosin. The only means used heretofore for the preparation of pyroabietic acids involved heat treatment of rosin or resin acids which resulted in a complex mixture, from which the separation of the pyroabietic acids was exceedingly difficult.

A rapid method for the isomerization of rosin and resin acids by catalytic means was devised. The catalytic procedure accomplishes the isomerization within a period ranging from 15 to 30 minutes, in comparison with from 80 to 100 hours required for the ordinary heat treatment, and produces a much better yield of the desired pyroabietic acid. Several catalysts were found to be effective, but palladium carbon was the best.

A number of resin acids and rosins from various sources were found to yield alphapyroabietic acid almost exclusively by the catalytic process of isomerization. The production of alphapyroabietic acid from resin acids and rosins from different sources by catalysis is of scientific, as well as industrial, interest because previous records indicate that resin acids and rosin from different sources yield different pyroabietic acids.

In the investigation of the components and derivatives of pine oleoresin, attention was directed during the year to the so-called neutral substances in the nonvolatile portion. These neutral substances, although present only to the extent of about 5 percent, have an influence on the properties of the rosin made from pine gum. An efficient automatic laboratory process for separating this group of substances from comparatively large quantities of gum was worked out. The neutrals from longleaf pine gum were found to be a complex mixture consisting of difficultly saponifiable esters of the abietic type, polymerization products, and ill-defined unsaponifiable oxygenated bodies similar to and including the so-called resenes. Certain components, which were found to be somewhat volatile under a high vacuum, closely resembled some of the less volatile components of the "tailings" left in the fractional distillation of

gum spirits of turpentine, and it is expected that further study of these components will throw light on the less-known tailings constituents of gum spirits.

Progress was made in the development of special methods of saponifying esters of the abietic type by conducting the saponification at high temperatures in solvents having high boiling points.

A study was made of methods for determining the degree of unsaturation of rosin products. A high degree of unsaturation is indicative of instability. Stability is a particularly important property in rosins from the point of view of industrial usefulness.

A laboratory technique, which does not require the use of fractionating columns, has been worked out for the identification of steam-distilled wood turpentine and differentiating it from gum spirits of turpentine. It involves the isolation of benzaldehyde and fenchyl alcohol and their subsequent identification in the form of characteristic derivatives.

A process for chlorinating turpentine was devised, in which the hydrochloric acid which is evolved, when chlorine is substituted in the pinene molecule, is utilized in the preliminary steps. By first saturating turpentine with hydrochloric acid and then with chlorine, a final product was obtained which contained more chlorine and was more stable to heat and light than when chlorine alone was used.

When rosins are dissolved in solvents for the preparation of gloss oils, spirit varnishes, and adhesives, crystals sometimes separate on standing. This makes the rosin solution unsuitable for the purpose for which it was intended. During the year a simple method was tried out for determining the tendency of any particular lot of rosin to crystallize from solution. This method consists of placing the rosin in small lumps in a test tube, covering with the solvent, and allowing to stand. A solution is formed, which varies from saturated at the bottom to very dilute at the top, and at some point the concentration is optimum for inducing crystallization. It was found that crystallization occurred much more readily by this method than when a uniform solution of 1 g of rosin per cubic centimeter of solvent was used. Fifteen samples of gum rosin, which gave trouble in commercial utilization because of crystallization, were found to crystallize from alcohol solution overnight, whereas most samples of gum rosin did not form crystals on standing for 2 days. Acetone proved more effective than alcohol for inducing rapid crystallization.

The quantity of metals in gum rosin is remarkably small, but the presence or absence of certain metals may be of importance in connection with certain uses of rosin. The ash of most rosins contains enough iron and zinc, or aluminum, to be identified by chemical means. Copper can be detected only occasionally, unless very large samples are used. Last year, with the collaboration of the Fertilizer Research Division of this Bureau, the presence of various metals in the ash from rosin was determined by spectroanalysis. A spectrogram of the ash from 100 g of commercial gum rosin of WG grade showed the presence of the following metals in the order of their abundance: Zinc, iron, lead, barium, aluminum, copper, manganese, magnesium, silicon, and boron. Similar determinations are being made on the ash from pine gum itself.

Efforts were made to find new uses for the compounds of resin acids with various metals. A copper resinate spray solution containing copper equivalent to that in a 5–5–50 bordeaux mixture was tried out for preventing late blight of potatoes, in cooperation with the Maine Agricultural Experiment Station, and was reported to give effective control under severe blight conditions. A dusting powder rather than a spray is desired, however, and work toward this end is being continued. Silver, cadmium, and copper resinates were tried out as mildew-proofing agents for cotton fabrics and found to be effective as long as they remained in the fabric. Weathering removes them in about 6 months. From experiments in which these resinates were used in combination with beeswax, however, it appears that their incorporation with wax finishes used commercially for waterproofing canvas would be feasible, and that they would not be readily removed when thus incorporated.

Processed oleoresin is now a commercial product and is being used experimentally by some industries. Advice has been given with regard to methods for determining the percentage of spirits of turpentine in the oleoresin and methods of distillation to insure recovery of all the turpentine without overheating and without having entrained rosin in the turpentine.

Examination of 10 samples of steam-distilled wood turpentine and 4 samples of destructively distilled wood turpentine, which had been stored for 9 years in large glass bottles in a moderately cool place and exposed only to subdued

daylight, showed that in instances where the bottles were full and tightly stoppered there had been no material changes in color or specific gravity.

Under the usual storage conditions, turpentine undergoes changes in composition, viscosity, and specific gravity due to oxidation, polymerization, and other action and becomes discolored from contact with metals, particularly iron and copper. It appears that at least some of the undesirable changes are promoted by the presence of dissolved or free water in the turpentine. Observations on samples of dehydrated turpentine, turpentine saturated with water, and turpentine containing free water, which had been stored for 3 years in contact with iron or zinc, and in some instances with oxalic acid crystals, showed that the turpentine in contact with water and metal did not change appreciably in specific gravity, although there was a decided darkening of color (most of which occurred during the first year) caused by the iron. The turpentine which had been in contact with zinc and water was still water-colored. Oxalic acid was not effective in preventing discoloration of turpentine by iron over the full period of storage, although it did prevent discoloration during the first year. The sample of turpentine used as a control had not changed appreciably in color, but it increased by 0.0015 in specific gravity. The turpentine which had been dehydrated with calcium chloride darkened two shades in color and increased by 0.0108 in specific gravity.

TECHNOLOGY OF NAVAL STORES

Experimental and demonstration work on the processing of pine gum was continued at the naval stores station in the Osceola National Forest at Olustee, Fla. The purpose of this work is to improve equipment and technique and thus lower the cost of production, yield standardized products, and prevent deterioration and losses in the handling of gum and its products.

A joint study of the fire still by the naval stores station and by cooperative agents in the field resulted in further changes in the standardization of fire-still plants. Plans and specifications were prepared for four types of plants adapted to different kinds of location and scale of operation. Studies on the distribution of heat in the fire path around the kettle led to changes in relative sizes of flues, whereby more even distribution of heat is obtained.

Approximately 550 barrels of gum were distilled with the fire still, principally for demonstration purposes. On the average, 14.2 man-hours were required for a 10-barrel charge. This is slightly more than the requirement for distilling crude gum with the steam still. The fuel requirements were less for the fire still than for the steam still.

An improved method was developed for distilling scrape in the fire still. It involves the addition of 1 barrel of water and 1 barrel of turpentine per charge and distillation in the usual manner. This method prevents the scrape from scorching, and thereby lowering the grade of rosin.

The steam turpentine still was used for the distillation of 1,500 barrels of cleaned gum and scrape diluted with from 9 to 43 percent of additional turpentine. On the average, 9.5 man-hours were required for a 10-barrel charge. In previous work with crude gum 14 man-hours were required. The time of charging the steam still with cleaned gum was reduced from a minimum of 30 minutes to 6 minutes by replacing the pump with an aluminum blow tank which also eliminates loss of turpentine in transferring the hot gum from the settling tank to the still.

The steam still, run intermittently as it is at the naval stores station, does not show any great advantage over the fire still in yields or costs. It is believed, however, that it would show greater efficiency if run continuously by large gum buyers or in connection with naval stores operations of 50 crops or more.

The gum-cleaning process previously developed was used experimentally in cleaning about 1,800 barrels of gum. Briefly, this process consists in filtering hot gum under steam pressure, subsequently passing turpentine through the equipment to clean the chips and filter medium and dissolve scrape, adding the turpentine to the filtered gum, adding hot water to and mixing it thoroughly with the gum and turpentine, allowing to stand overnight, and drawing off the lower layer of wash water which contains soluble impurities.

The investigational work on gum cleaning has yielded the following results thus far: (1) Development of a simple process involving filtration and washing; (2) production of a clean rosin having an average brightness of 96.2 percent, compared to 80 percent or less for commercial rosin from uncleaned gum; (3) production of rosin which is usually one or more grades lighter in color than

rosin made from the same gum uncleaned; and (4) substantial increase (from 2 percent for straight gum up to 8 percent for straight scrape) in the yield of rosin due to elimination of rosin losses in chips and dross.

Work was continued during the 1936–37 naval stores season with the turpentine-gum cups which had been under test during the previous three seasons, namely, galvanized iron, zinc, aluminum, clay, lead-coated galvanized iron, and gumwood. Gum collected in the galvanized-iron cups continued to yield low grades of rosin (D to H), and the cups were discarded at the end of the season; gum collected in the lead-coated and gumwood cups yielded medium grades of rosin (I to N); and that collected in the zinc, aluminum, and clay cups yielded pale grades (M to WW).

Experiments with cone-shaped wood cups, provided by the Forest Products Laboratory, gave promising results. Such cups can be made from the cores left from the manufacture of veneer, which now are used only for fuel. Molded cups made from phenol-formaldehyde synthetic resin were tried also, but these imparted a yellow color to the gum, which darkened the rosin. Continued experiments with cone-shaped glass cups indicated that these offer great promise.

In preliminary tests on the use of hydrochloric acid to stimulate the flow of pine gum, the application of acid to a normal streak (one-half inch) caused a gradual decrease in the yield of gum. The application of acid to a 1-inch streak increased the yield by about 50 percent.

Continued experiments on the comparative serviceability of galvanized-steel and white-oak dip barrels indicated that the metal barrels have certain advantages, as follows: They do not leak, except at top head; they have a definite and constant capacity; they have constant tare weight; they last longer than wood; and there is little or no cost for keeping them in good condition. The disadvantages of the metal barrels are that they are not obtainable locally; their first cost is higher than that of wooden barrels; they are harder to handle; they are easily dented; and the galvanized coating breaks down slowly, allowing the gum to be stained by iron.

In experiments on the straining of rosin it was found that, by increasing the "turning-out" temperature from 315° to 325° F., better and more rapid straining was obtained without apparent injury to the rosin. It was also found that straining will be satisfactory if the charge is turned out when the temperature in the still is rising instead of falling. Tests with different kinds of strainer wire indicated that 30-mesh bright steel wire produces as good a strainer as more expensive copper or brass wire of similar mesh, and furthermore it will not stain the rosin.

Seasoning of rosin barrel staves prior to coopering was found to require greater care in assembling the barrel. Coopering is more difficult, and many of the staves, particularly those having knots, break when the barrels are filled. Cooperative tests with the Forest Service on the value of the zinc-chloride treatment of rosin barrel staves for increasing the resistance of barrels to decay in open-air storage of rosin were completed. After 2 years of storage the barrels made of ¾-inch kiln-dried, zinc chloride-treated staves had broken down to the point where recoopering was necessary.

During the year the naval stores station was visited by 762 persons, including 291 students and 13 instructors. Lectures and demonstrations were given to show the nature and purpose of the work. Eighteen demonstrations were given on the fire still, including 3 during training periods for technical turpentine workers, at which 75 workers were present. Eleven demonstrations were given of the method for cleaning gum and distilling it on the steam still. Information relating to naval stores production was given in 61 conferences and 167 letters.

Fifty-four turpentine operators in 4 States were visited by the accounting clerk, and 25 complete statements of operating costs were obtained. These data will be used in comparing the cost of each step and method of handling and processing the gum at the station with the cost of comparable operations in the industry.

Blueprints, line prints, and pencil sketches for still buildings, stills, and various kinds of equipment, to the number of 483, were distributed in response to requests from interested persons.

COOPERATION WITH STATES IN NAVAL STORES WORK

Cooperative agents continued to disseminate to naval stores producers in Florida and Georgia information concerning the improvements in practices and equipment for the production of naval stores developed at the naval stores station, by making personal contacts with producers individually or in groups.

Information on various subjects relating to the production of turpentine and rosin were given in Florida to naval stores operators, gum farmers, landowners, and students in 343 personal contacts and 195 letters. The cooperative agent directed the erection of 18 turpentine fire stills and 5 still sheds according to plans and specifications approved by the Bureau, and he advised operators with regard to installation of 5 dehydrators, 15 covered separators, 7 recording thermometers, and 10 sets of rosin strainers. Twelve demonstrations of the improved method of stilling with regulatory equipment were given in the field on fire stills set in accordance with the Bureau's recommendations.

The cooperative agent made 180 visits to turpentine operators in Georgia, assisted in the setting of 25 stills, and furnished plans and specifications for and assisted in the construction of 13 model still plants. Several plants previously constructed with the aid of the cooperative agent have been copied by other naval stores operators; one has been copied for the fourth time. This shows the importance of these model still plants.

NAVAL STORES STATISTICS

Two statistical reports on naval stores were compiled and published during the year. One was issued on October 30, 1936, and the other on June 1, 1937. These reports give statistics on production, distribution, consumption, and stocks of turpentine and rosin, and they are designed to assist naval stores operators in adjusting production to probable demand. Tables of naval stores statistics for the seasons from 1900 to 1935 were also prepared for the Department's publication entitled, "Agricultural Statistics, 1937."

OIL, FAT, AND WAX INVESTIGATIONS

LIQUID WAX FROM JOJOBA SEEDS

In last year's report it was stated that the seeds of *Simmondsia californica* had been found to contain over 51 percent of oil, which was exceptional, in that it contained 48.3 percent of unsaponifiable constituents. During the year, a comprehensive study was made of the material extracted from these seeds with petroleum ether. Although it has the appearance of a fatty oil, it is in reality a liquid wax. It is like the liquid wax obtained from the sperm whale, so-called sperm oil, in that it consists essentially of esters of unsaturated alcohols and unsaturated fatty acids. It differs from sperm oil, however, in the particular esters of which it is composed and also in its properties. When cooled to about 10° C. it solidifies. After heating for a short time at about 250°, the color changes from yellow to almost water-colored and remains so permanently. Its physical and chemical characteristics are as follows: Density at 25°, 0.8642; refractive index at 25°, 1.4648; iodine number (Hanus), 81.7; saponification value, 92.2; and acid value, 0.32. It contains about 1.64 percent of saturated fatty acids, 0.24 of palmitoleic acid, 30.3 of eicosenoic acid, 14.2 of dicosenoic acid, 14.6 of eicosenol, and 33.7 of dicosenol. Apparently it is entirely free from fatty oil or glycerides, since tests for glycerin were negative. Uses for this unique product remain to be discovered.

Simmondsia californica, commonly known as jojoba, or goat nut, is an evergreen shrub belonging to the box family, Buxaceae. It grows wild on hillsides in the somewhat arid sections of southwestern United States and western Mexico and is browsed by sheep and goats, especially during the dry winter season. Up to the present time this shrub is the only plant known to have seeds in which a liquid wax is elaborated in place of fatty oil.

OIL FROM NUTS OF JAPANESE "WOOD-OIL" TREE

Because of the growing importance of the seed oils of the genus *Aleurites*, the oil was expressed from the kernels of a 50-pound sample of *A. cordata* nuts, received from Japan through the Division of Plant Exploration and Introduction of the Bureau of Plant Industry, and its composition and properties were determined. The purpose of the Bureau is to obtain adequate comparative data on the composition and properties of the several industrially useful drying oils of related species through modern investigational methods. The Department is interested in the possibility of growing some of these species of nuts in the United States or its possessions.

The kernels, which constituted 63.8 percent of the weight of the nuts, contained 67.5 percent of pale-yellow oil which was somewhat similar in compo-

sition and properties to tung oil and only slightly inferior to that oil in drying properties. It contained 70.5 percent of elaeostearic acid, 18.5 of oleic acid, and 6.2 of saturated acids. Its physical and chemical characteristics were as follows: Refractive index at 25° C., 1.5060; saponification value, 190.2; acid value, 0.60; thiocyanogen value, 80.9; and iodine number (by calculation) 209.6. The properties of this oil make it valuable for use in the manufacture of paints, varnishes, and linoleum.

OIL FROM NUTS OF LUMBANG, OR CANDLENUT, TREE

A study was also made of the oil expressed from the kernels from about 100 pounds of lumbang nuts, or candlenuts, from the tree *Aleurites moluccana*, received from the Philippine Islands. Unlike the nuts of other *Aleurites* species, lumbang nuts have thick shells and the kernels adhere to them very tenaciously. The kernels, constituting about one-third of the weight of nuts, contained 69.2 percent of oil which differed from those of other *Aleurites* species in that it gave no test for elaeostearic acid. In composition and properties the oil is somewhat similar to linseed oil. It contained 26.2 percent of oleic acid, 39.6 of linoleic acid, 20.8 of linolenic acid, 4.4 of palmitic acid, 3.9 of stearic acid, about 0.1 of arachidic acid, and 0.3 percent of unsaponifiable matter. The chemical characteristics were iodine number (Hanus) 151.71, saponification value 190.8, and thiocyanogen value, 97.1. Commercial production of lumbang oil appears to be confined to the Philippines, where it is used chiefly in the manufacture of paint and varnish.

OIL FROM FRUIT SEEDS OF BRAZILIAN PALM

About 6 pounds of fruit from the Brazilian palm (*Syagrus coronata*) grown at Lake Worth, Fla., were submitted by the Bureau of Plant Industry for investigation. They were pale yellow and the size of small plums. They consisted of 47.5 percent of pulp and fiber and 52.5 percent of seeds or nuts, one to each fruit. The pulp contained a red oil which amounted to only 0.88 percent of the whole fruit. It is of no commercial interest because of the small yield.

For a study of the oil from the kernel, which has recently become of commercial interest, the oil was expressed from a 25-pound sample of kernels imported from Brazil. This contained 79.6 percent of saturated acids, 14.2 of unsaturated acids, and 0.3 percent of unsaponifiable matter. The following characteristics were determined: Iodine number, 14.7; saponification value, 256.9; thiocyanogen value, 12.78; Reichert-Meissl value, 5.93; and Polenske value, 18.38. There is some evidence that the oil contains an unusually large quantity of caproic acid which occurs only in traces and sometimes apparently not at all in coconut oil. It has the lowest solidification point (about 60° F.) observed in any palm-kernel oil. As there is no information in the literature on the composition of this oil, and numerous requests have been received for such information, further investigation is planned for the purpose of supplying it.

PHOSPHATIDES OF SOYBEAN OIL

In view of the rapidly growing importance of the domestic production and utilization of so-called vegetable, or soybean, lecithin preparations, it seemed desirable to make a further study of the soybean phosphatides. These phosphatides were extracted from soybeans by means of ethyl alcohol at 60° C. This treatment apparently removes phosphatides which are in combination with proteins and carbohydrates, as well as those present in a free state. The phosphatides were separated from extracted carbohydrates by solution in ethyl ether. Treatment of the concentrated ether solution with acetone yielded two acetone-insoluble and two acetone-soluble fractions. The acetone-insoluble alcohol-soluble fraction consisted of lecithin in combination with a betaglucoside. The acetone-insoluble alcohol-insoluble fraction consisted of cephalin in combination with another compound of about equal molecular weight. The third fraction, soluble in acetone, contained diamino-monophosphatides, and the fourth fraction, soluble in acetone, contained monoamino-diphosphatides.

PROTEIN AND NUTRITION RESEARCH

PROTEINS OF WHEAT

The wheat kernel contains eight or more different proteins. Of these, only two, gliadin and glutenin, have been extensively studied. Little definite knowledge

is available regarding the others, either with reference to the relative proportions in which they are present in the kernel, or with reference to their amino acid content. The Bureau is frequently asked how much there is of particular amino acids in wheat, corn, oats, or other feed. The owner of a sheep ranch or fur farm who has read somewhere that cystine is important for the production of wool or fur may want to know how much cystine there is in certain foods for sheep or fur-bearing animals. Unfortunately, in most instances no satisfactory answer can be given. Usual methods for determining amino acids are applicable only to isolated, purified proteins. Interfering substances, such as carbohydrates and fats, preclude the application of these methods to the analysis of foodstuffs.

Realizing the importance of knowing how much of each nutritionally essential amino acid is present in various kinds of food or feed as used rather than in the purified proteins, the Protein and Nutrition Research Division developed a method for determining amino acids in staple foods, such as cereals, flours, meals, and seeds. During the last year this method was used to determine a number of nutritionally essential amino acids in whole wheat and its milling products, flour, middlings, and bran. Two papers were published giving information on the amino-acid content of wheat and on the effect of milling on the distribution of amino acids of wheat. Significant differences were found between the amino-acid contents of different varieties of wheat. Wheat varieties having a high nitrogen content (hard wheats) contain relatively higher percentages of the important amino acids than do those varieties having a low nitrogen content (soft wheats).

PROTEINS OF THE BLACK BEANS OF THE MAYAS

A study was made of the proteins of black beans obtained from Costa Rica through the Bureau of Plant Industry. It is reported that the diet of the Mayas, a sturdy and hardy tribe of Indians, consists almost entirely of corn and these beans. The proteins of this variety of bean and their amino-acid composition were studied to find out how well they supplement the proteins of corn in the diet and how they compare with the proteins of other varieties of beans previously studied. Two globulins were isolated, and their contents of the amino acids, arginine, histidine, lysine, cystine, tryptophane, and tyrosine, were determined.

The results of these studies showed that the proteins of these black beans share, in general, the same biological properties as the proteins of other botanically related legume seeds, namely, a pronounced deficiency of cystine and a high content of lysine; also, that they contain a liberal amount of tryptophane, another nutritionally essential amino acid. The proteins of corn, on the other hand, contain an adequate amount of cystine, but are deficient in lysine and tryptophane. When these black beans and corn are used together, there is a supplementary relationship between their proteins with respect to their amino acid content.

TRYPTIC DIGESTION OF CASEIN

In connection with the study, previously reported, on the rate of liberation of cystine from casein during laboratory digestion with trypsin, the question arose as to whether or not some of the cystine measured might have originated from the trypsin itself (containing 1.68 percent of cystine) as a result of autodigestion. In experiments carried out to throw light on this question it was found that when trypsin alone was digested a very significant amount of cystine was liberated. However, when casein which had been freed of cystine was digested with trypsin no cystine was found in the digest. This result indicates that in the presence of other protein in the digestion mixture the proteolytic activity of trypsin is exercised exclusively on the substrate without any appreciable autodigestion of trypsin taking place.

DECYSTINIZED CASEIN

Casein is generally used to supply the protein of basal rations employed in the biological assay of vitamins and as a control in experiments to evaluate the nutritional properties of proteins. It is also frequently used as a standard protein in certain determinations connected with protein and amino acid analyses. For these purposes the casein is first purified, frequently by dissolving it in dilute alkali and then reprecipitating with acid. The destructive effect of this treatment on the cystine has not been recognized generally or

taken into consideration in determining nutritional values. This fact undoubtedly has introduced errors into some past work and may account for a number of unexplained discrepancies which have been noted in publications in the field of nutrition and protein chemistry. Although alkali-treated casein is disadvantageous for some purposes, it occurred to the Bureau's protein chemists that casein which had been entirely freed of cystine by alkali treatment would be of value in the investigation of a number of problems.

By repeated treatment of casein with dilute alkali and reprecipitation with dilute acetic acid, a product was obtained which was substantially devoid of cystine. This product, as far as it has been analyzed, appears to have otherwise the same amino acid composition and the same distribution of nitrogen as the original untreated casein. A sufficient quantity of decystinized casein has been prepared recently, in order to allow a more thorough study of its chemical and physical properties and digestibility, and its uses in feeding experiments. The feeding experiments with this unique protein material are expected to elucidate a number of fundamental problems regarding the role played by the sulphur-containing amino acids, cystine and methionine, in nutrition.

SELENIUM IN TOXIC WHEAT

Work was continued on the properties and identity of the toxic organic selenium compound or compounds existing in wheat grown on seleniferous soils. Gluten separated from toxic wheat has been hydrolized with sulphuric acid and the resulting mixture of amino acids fractionated. One of the fractions, consisting chiefly of leucine and phenylalanine with smaller quantities of other amino acids present, contained most of the selenium which was originally present in the gluten hydrolyzed. This fraction was prepared repeatedly, and various methods were used in trying to separate the selenium compound from the amino acids.

In one method the selenium-containing fraction dissolved in water was subjected to direct electric current under high voltage. Under certain conditions the selenium, together with some of the leucine and tyrosine, migrate to the negative electrode. Although a clear-cut separation of selenium from amino acid was not accomplished, a mixture containing a higher concentration of selenium was obtained. Conditions governing migration of the selenium compound, such as temperature, pH value of the solution, voltage, and current, were studied.

In another method, a solution of the selenium-amino acid fraction was treated with mercuric chloride, whereby a precipitate was formed carrying practically all of the selenium. This product, containing about 2 percent of selenium, is only very slightly soluble, even in comparatively strong sulphuric acid or hydrochloric acid solutions. Because of this unusual property a successful decomposition of the salt and separation of the selenium compound from the mercury has not yet been accomplished. Qualitative tests for sulphur in the selenium-mercury precipitate gave negative results. This lends support to the belief that selenium in the wheat protein is not merely a substitute for sulphur in the amino acids cystine or methionine, as frequently has been suggested.

EFFECT OF STORAGE ON PROTEINS OF SOYBEAN OIL MEAL

It has been observed that the proteins of some seed meals may lose about one-half of their nutritive value within a few weeks after grinding. These observations have suggested that similar changes may occur when unground grains or other seeds are held in storage.

An investigation has been started, therefore, in which chemical and biological experiments are made to determine the nature and extent of changes which take place in the proteins of grains and other seeds and their mill products, when stored for periods ranging from 1 month to 2 years or longer. Particular attention is given to storage conditions, such as temperature, moisture, exposure to light, type of container, and fat content, which may hasten or retard deterioration.

Chemical analyses and tests on freshly ground soybeans and on the same meal after storage periods of 1 month and 3 months showed that within 1 month changes took place in the chemical properties, solubility, and digestibility of the proteins, which indicated an alteration in the integrity of the protein structure. These changes occurred to a greater extent in meal stored at ordinary temperature than in that stored at refrigeration temperature. After

3 months of storage, the changes were more pronounced. Sufficient data have not yet been obtained to justify the drawing of conclusions regarding the nature and ultimate extent of the changes caused by storage.

VITAMIN B COMPLEX IN SOYBEANS

In order to develop information required in formulating the rations to be used in feeding experiments, a study was made of the vitamin B complex of Mammoth Yellow soybeans harvested in the late fall of 1936. If the soybeans contained an adequate amount of the vitamin B complex it would be unnecessary to supplement the soybean rations with vitamins from other sources. It was found that sufficient vitamin was supplied by this particular variety and lot of soybeans when the soybean oil meal constituted 20 percent of a ration otherwise free from vitamin B complex. No improvement in rate of growth was observed when the soybean oil meal content of the rations was increased beyond 20 percent.

VITAMIN STANDARDS

The Bureau has continued to distribute the international vitamin standards received from the Health Organization of the League of Nations. These standard samples have been issued on request to vitamin investigators in the United States, working in colleges, universities, and agricultural experiment stations.

VITAMIN ASSAY OF ROYAL JELLY

Royal jelly is the special food which bees feed the larvae, in order to develop queens for their colonies. It has the property of greatly stimulating growth in bees and in developing the female sex characteristics, but the component to which these remarkable properties may be attributed is not known. Some work has been done outside the Department on the vitamin E content of royal jelly, but the results obtained are conflicting. Studies on the vitamin assay of royal jelly have recently been started at the request of the Bureau of Entomology and Plant Quarantine. The results are expected to be useful in connection with the development of synthetic rations for use in studying problems related to bee culture.

ALLERGENS OF AGRICULTURAL PRODUCTS

A study of allergens of agricultural products was carried on during the year as a part of the Department's program of basic research in agriculture, provided for in the Bankhead-Jones Act of June 29, 1935.

Clinical facilities were organized at Providence Hospital in Washington, for determining the potency and specificity of fractions prepared in the laboratory from allergenic products. Approximately 300 patients of the 1,200 who have visited the allergen clinic have been registered and classified for testing with materials of special significance. About 70 patients have been under continual study, in order to determine the activity of fractions derived from milk, ragweed, buckwheat, cotton linters, and cottonseed.

Experiments were made to determine if milk may contain allergens derived from the dairy ration. Ragweed allergen was not detected in the milk of cows fed on ragweed tops or in fractions prepared from this milk.

New cotton linters were found to be free from soluble allergens affecting individuals who are sensitive either to house dust or to cottonseed. Storage experiments with small quantities of linters under various controlled conditions are in progress, to determine if this material generates a specific dust allergen on aging. Extracts prepared from cotton linters taken from a bale which had been in storage for 9 years were consistently negative when tested on clinical patients sensitive to dust and cottonseed allergens. These extracts contained only a trace of nitrogen.

Fractionation of allergen extracts from cottonseed, so as to concentrate the active principle while decreasing the total protein content, was accomplished by subjecting the solutions to the action of a direct current of electricity which caused the cottonseed allergen to migrate toward the positive electrode. An active fraction was obtained which contained only a small proportion of the nitrogen in the original crude extract. When the current was allowed to act for a long time all fractions were completely inactivated. When an extract of ragweed pollen was similarly subjected to the action of an electric current, the allergen migrated toward the negative electrode. The ragweed allergen was more stable than the cottonseed allergen when the current was allowed to act for long periods.

Preparations containing allergens of buckwheat, wheat, and cottonseed were used as substrates for comparing the enzymic activity of blood from normal and allergic subjects. Measurable differences were observed for the total enzymic activity of blood from different subjects. Whether these differences are related to the constitution of allergens cannot be concluded from the data now in hand.

CHEMICAL ENGINEERING RESEARCH

The work of the Chemical Engineering Research Division during the year has included investigations on the causes and prevention of fires and explosions in the handling, storage, and processing of agricultural materials and of other accidents of a chemical nature on a farm and in a rural community; also engineering design, drafting, and development services to other divisions of the Bureau.

AGRICULTURAL FIRES

One of the main causes of fires on farms is the spontaneous ignition of hay and other organic materials. The Bureau has found that one of the principal factors contributing to spontaneous heating and possible ignition of hay is a high moisture content, and that purely chemical, as well as microbial, action is involved. Even a moderate degree of self-heating in hay results in the loss of organic substance which reduces its feeding value.

Laboratory and field investigations were continued on the causes, results, and prevention of spontaneous heating in hay. A large-scale experiment on first-cutting alfalfa hay (1936 crop) was completed in the experimental barn at the National Agricultural Research Center, Beltsville, Md. The primary object of this experiment was to determine the effect of an elevated openwork floor and open alleyway on the rate of drying of undercured long hay in storage and dissipation of the heat produced. The mow was divided into two compartments, each 12 by 23 feet, separated by a wooden partition of 2 by 4's covered on each side with insulating board seven-eighths of an inch thick. One compartment had an elevated false floor made of 2 by 4's set on edge with 4 inches between faces across 2 by 8's set on edge with about 3 feet between centers and notched so that the upper edges were flush with those of the 2 by 4's. There was an open alleyway at one end of each compartment. About 12 tons (eight loads) of hay were put in each compartment as uniformly as possible, and special care was taken to have the hay in the two compartments as similar as possible. Each load was sampled for moisture content. The average moisture content of the hay in the ventilated compartment was 36.82 percent; that of the hay in the other compartment was 38.62 percent. The height of hay in the ventilated compartment was 15 feet; that of the hay in the other compartment was 14½ feet. The hay was left in the mow for practically 8 weeks in June and July. During this period the temperatures of the hay in the two compartments, in corresponding positions at different levels, were recorded, and the relative upward velocities of air near the surface of the hay in the two compartments were observed, by means of suitable instruments. The results of this experiment indicated that the use of an openwork support in the storage of long hay in mows of moderate size is desirable as a means of reducing deterioration due to heating. The advantage of using such a false floor in mows of great height is doubtful, because dense packing of the haymows might prevent adequate aeration.

A member of the Chemical Engineering Research Division's staff conferred with representatives of two State agricultural colleges and one State agricultural experiment station with regard to current and contemplated investigations on spontaneous heating and ignition of hay, gave information and advice to two manufacturing firms which are experimenting with special structures and containers for chopped hay, and twice addressed the American Society of Agricultural Engineers on the subject of spontaneous heating and ignition of hay.

At the request of farmers in the Ohio River Valley in the vicinity of Point Pleasant, W. Va., members of the chemical engineering staff investigated spontaneous heating in haymows, which resulted from wetting by the floodwaters of January 1937. Temperatures as high as 65° C. (149° F.) were found in several large mows. The hay was removed and scattered, in order to prevent spontaneous heating to the point of ignition. In several instances, soybean hay in bales had heated so severely that it had to be dumped into the water to prevent an outbreak of fire.

Detailed instructions for handling mows and stacks of heating hay were made available.

Experiments were continued in the laboratory to determine whether the easily oxidizable unsaturated products previously indicated as present in heating hay resulted from heat alone. It was found that heating of hay in an inert atmosphere results in an increase in the oxygen absorption by the hay. Progress has been made in the study of the fatty substances of hay, which largely are lost as the result of self-heating. Experiments to determine the gaseous decomposition products of hay heated to various temperatures in an atmosphere of nitrogen, with special reference to the formation of carbon monoxide, are still in progress.

Members of the Bureau's chemical engineering staff cooperated with organizations interested in fire prevention, by participating in conferences and meetings, and in the work of committees on which they held membership. These organizations included Underwriters' Laboratories, Chemical Fire Extinguisher Association, State Association of Mutual Insurance Companies of Michigan, Mutual Insurance Companies' Union of Indiana, American Society of Agricultural Engineers (committee on fire prevention and protection), National Fire Waste Council of the Chamber of Commerce of the United States, and its agricultural committee, and the National Fire Protection Association (committees on farm fire protection and spontaneous heating and ignition). The National Fire Protection Association was assisted in the preparation of its spontaneous heating and ignition committee's report on Spontaneous Heating and Ignition of Coal and Other Mining Products, in the revision of its farm fire protection committee's report on Rural Fire Departments, Equipment, and Organization, and in the preparation of the same committee's tentative report covering desirable provisions in State laws on rural fire protection, suggested model laws establishing fire-protection districts and providing fire protection and proposed model ordinance for the organization and administration of volunteer fire departments.

DUST EXPLOSIONS

Progress has been made in reducing the dust-explosion hazard in industrial plants handling or processing agricultural products. As a result of the research work carried on in the laboratory and at the dust-explosion testing station at Arlington Experiment Farm, many precautionary measures have been developed and made available in the form of recommended safety codes for the prevention of dust explosions.

Thirteen explosions in industrial plants, involving dusts from agricultural materials were investigated by the Bureau during the past year. Four of these were caused by grain dust, two by cotton floc or lint, six by wood dust, and one by dust from powdered drugs. These explosions resulted in the death of 14 men, injury to 43, and property damage amounting to about $1,147,000. The most serious explosion occurred in a corn milling plant at Milwaukee on April 10, 1937. It resulted in the death of 9 men, injury to 24, and a property loss of about a million dollars. In five of the explosions the property losses ranged from $10,000 to $40,000, and in the others they ranged from $1,000 to $5,000.

The recent establishment of new industries using agricultural products and the increased utilization of byproducts have broadened the field of research and experimental work necessary to develop the additional safety measures required for the protection of these industries from dust explosions. The rapid growth in the production of soybeans has encouraged the erection of plants for their industrial utilization. As a result, there has been an increase in the number of establishments subject to the hazard of possible ignition of dust or volatile solvents during the milling and processing of the beans. Two explosions in soybean processing plants in 1935 resulted in the loss of 13 lives, injury to 47 persons, and a property loss of over $600,000. These explosions indicated the importance of developing and applying safety measures in plants of this kind, and the Chemical Engineering Research Division is working on this problem.

Tests to determine the breaking strength of glass used as explosion vents were continued during the year. Special attention was given to the possibility of scoring glass in order to reduce its resistance to pressure from within a building without seriously lowering its resistance to wind pressure from without. Scoring with a diamond proved more effective than with a steel glass cutter. Tests are under way to determine the effect of prolonged exposure to weather on the breaking strength of scored glass.

During the year experiments were continued to determine the conditions under which dust clouds may be ignited by metallic sparks.

A number of dust samples submitted by manufacturing firms and representatives of organizations interested in prevention of accidents were tested during the year to determine their explosibility. Those which were found to form explosive mixtures with air included soap powders, pulverized bagasse, grain-elevator dusts, carbohydrate adhesives, casein dust, wood dusts, soybean flour, soybean-protein dust, wood-pulp fines, powdered vegetable char, and spray-dried sulphite cellulose waste. Samples of powdered stearic acid when mixed with air were very explosive.

The results of the Bureau's work on prevention of dust explosions were presented at 11 firemen's training schools (in 10 States and the District of Columbia) and before 2 firemen's conventions; the fire departments of 8 western cities; 11 student groups at high schools, colleges, and universities; 2 civic organizations; and the annual gathering of the 4–H Clubs in Washington, D. C. In addition, addresses were given before the Factory Inspector's School at Chicago, the Chicago Engineers' Club, the engineering section of Chicago Safety Council, the American Soybean Association, and a conference of fieldmen of a southern grain company.

In connection with their work on dust-explosion prevention, members of the chemical engineering staff cooperated with national organizations by active participation in the work of committees on which they held memberships or before which they were requested to appear. The dust-explosions hazards committee of the National Fire Protection Association, of which the chief of the Chemical Engineering Research Division is chairman, was assisted in amending the safety code for the prevention of dust explosions in grain elevators to provide for the use of dust-proof enclosures for conveyor belts and in the formulation of a general safety code embodying the fundamental principles for the prevention of dust explosions in industrial plants. This new code is intended for the many plants which have some dust-explosion hazard but for which no specific code has been prepared. The blower and exhaust systems committee of the National Fire Protection Association was assisted in revising the code covering the installation of blower and exhaust systems for dust, stock, and vapor removal and in drawing up additional regulations for the installation of ventilating and air-conditioning systems. The static electricity committee of the same organization was assisted in the preparation of a safety code designed to call attention to the hazard of static electricity in industry and containing recommended safe-practice regulations. The conveyor committee of the American Standards Association was assisted in the preparation of a safe-practice code for installation and use of conveyors.

SILO GAS ACCIDENT

Members of the chemical engineering staff investigated the accidental death on September 3, 1936, of a mother and two daughters in a pit silo on a farm near Poplar Springs, Md. The younger child collapsed while playing in the silo containing fresh silage, and the mother and other child lost their lives in attempting to rescue the little girl. The investigation indicated that these deaths were caused by suffocation in an atmosphere deficient in oxygen. Samples of the gas in the silo were collected 16 hours after the tragedy occurred, during which period another load of silage had been added. The gas taken at the surface of the silage contained about 10.5 percent of carbon dioxide and between 18 and 18.5 percent of oxygen. A sample of gas taken 2 feet below the surface of the silage contained over 91 percent of carbon dioxide and not more than 1.5 percent of oxygen.

This case emphasizes the dangerous condition which may exist in silos, especially of the pit type, during the storage of fresh silage, when large quantities of carbon dioxide gas are evolved as a result of the fermentation process.

A warning with recommended procedure for preventing such accidents was issued through the Department's press service and radio service.

GAS EXPLOSION IN TEXAS SCHOOL

At the request of Gov. James V. Allred of Texas, an investigation was made of the consolidated-school-building explosion at New London, which occurred on March 18, 1937. Definite information was obtained as to the source of ignition for the gas which had accumulated under the main part of the building. The report of this investigation, which was transmitted by the Department to Senator Connally of Texas on April 14, was printed as a Senate document (75th Cong., 1st sess., Doc. No. 56).

SERVICE WORK

One member of the chemical engineering staff was detailed during the entire year to the Naval Stores Research Division for engineering work in connection with technological investigations on the production and utilization of turpentine and rosin.

In collaboration with the agricultural byproducts laboratory of the Industrial Farm Products Research Division, designs were prepared for the special metal equipment to be used in pilot-plant experiments on the production of paper pulp from farm wastes and on the production of organic acids from sugars by mold fermentation. Plans and specifications were prepared for laboratory equipment for rooms in the South Building, and some time was given to the preparation and revision of estimates for construction and equipment of proposed buildings at Beltsville.

FERTILIZER RESEARCH

In the Bureau's fertilizer investigations, fundamental research is conducted on the ultimate structures and the physical and chemical properties of the elements and compounds contained in fertilizer materials, on the kinetics of the chemical reactions involved in the fixation of atmospheric nitrogen and other processes of fertilizer manufacture, and on the mechanism of nitrogen fixation by living organisms. Laboratory procedures are devised for the preparation of potential fertilizer materials in quantities sufficient for studies of their reactions with others and for vegetative tests, in cooperation with other units of the Department and with State agricultural experiment stations. New processes for the manufacture of fertilizer are tested on a semicommercial scale which serves to demonstrate their feasibility to the industry. Economic and statistical studies on the production and utilization of fertilizer are made also.

CATALYSTS IN NITROGEN AND PHOSPHATE FERTILIZER PRODUCTION

Studies on the kinetics of the synthesis and decomposition of ammonia were continued for the purpose of ascertaining how iron synthetic-ammonia catalysts function and the mechanism through which promoters modify the properties of such catalysts. Variations in the particle size of the catalyst were found to have no influence on its activity. This indicates that not merely the geometric surface, but the internal, or inner, surface of the particles is of importance in catalysis. Endeavors to modify the surface characteristics of an iron synthetic-ammonia catalyst, singly promoted by a 10.2-percent content of alumina, by reduction and deposition of tiny active iron crystals thereon from iron pentacarbonyl were unsuccessful because of inability to cause decomposition of carbonyl on the inner surface of the catalyst with the apparatus employed. Experiments which aimed at the incorporation of potash as a second promoter into the surface of an iron catalyst that already contained alumina met with success; the sorptive capacity of the resultant catalyst indicated that about 50 percent of the surface was covered with an alkaline promoter, and the energy of activation for ammonia decomposition was found to have increased from 25,000 calories per molecule of ammonia, which is apparently characteristic for the iron-alumina catalyst, to about 40,000 calories per molecule of ammonia. The latter value is about the same as that found for doubly promoted catalysts prepared according to the usual procedure by incorporating both alumina and potassium oxide in molten magnetic iron oxide and reducing the product.

The method for measuring the surface areas of iron synthetic-ammonia catalysts, by determining the adsorption isotherms of gases near their boiling points, described in the report of 1935 and mentioned in the report of 1936 as having been found applicable to the determination of the surface areas of other finely divided materials, such as pumice, glaucosil, chromium oxide gel, and crystalline chromium sesquioxide catalysts, apparently can be applied also to the measurement of the relative and absolute surface areas of soils and soil colloids. By use of this procedure, surface-area values for samples of Barnes soil, Barnes soil colloid, Cecil soil, and Cecil soil colloid were found to be equivalent to 4.2, 3.2, 8.0, and 5.5 acres per pound, respectively. Calculated values for the colloid content of soils, obtained by use of such surface-area values, were in good agreement with the values obtained by mechanical analysis. By means of the same method, alumina, when present as a promoter in an iron synthetic-ammonia catalyst, has been shown to accumulate on the

surface of the catalyst in such a maner that a small percentage thereof in the catalyst covers a relatively large fraction of the surface; thus, 10.2 and 1.03 percent of alumina in two samples covered 60 percent and 35 percent of their respective surfaces.

Continuation of the investigations on the oxidation of phosphorus vapor with carbon dioxide showed the lower oxide of phosphorus, mentioned in last year's report, to be phosphorus tetroxide. Efforts to convert this to phosphorus pentoxide by oxidation at temperatures below those at which the carbon monoxide, the product desired for the manufacture of hydrogen for ammonia synthesis, also would burn were without success. It was found, however, that the passage of the original mixture of phosphorus vapor and carbon dioxide through a layer of phosphate rock heated to 1,000° C. resulted in complete oxidation of the phosphorus to the pentoxide which combined with the rock to produce calcium metaphosphate, a compound containing in excess of 65 percent of P_2O_5. These investigations have, therefore, led to a process whereby phosphorus-carbon monoxide mixtures, such as are obtained in electric furnaces for the reduction of phosphate rock, can be made to react with carbon dioxide in the presence of additional phosphate rock to produce carbon monoxide and calcium metaphosphate, which when finely ground appears suitable for use as a concentrated phosphatic fertilizer; the process conserves all the carbon monoxide present in the furnace gases and produces an equal additional quantity.

PHYSICAL CONSTANTS OF GASES AND FERTILIZER SALTS

In continuation of the program to obtain by direct experimental determination a knowledge of the compressibilities of ammonia, hydrogen, nitrogen, and their mixtures for the calculation of volumes, pressures, viscosities, thermal conductivities, specific heats, and other thermal quantities under the variety of conditions encountered in the synthesis of ammonia, the compressibilities of an 87 : 13 hydrogen-nitrogen mixture at 0°, 25°, and 50° C. and at pressures from 25 to 1,000 atmospheres and of a 50 : 50 hydrogen-nitrogen mixture at 0°, 25°, 50°, 100°, 200°, and 300° over the same pressure range have been measured. A knowledge of the ammonia that is left in the vapor phase at different temperatures and pressures when the ammonia is condensed out from gaseous mixtures is important; consequently, previous measurements were extended to include determinations of the vapor content of ammonia in ammonia-hydrogen mixtures at 0° and 100° at various pressures. The solubilities of hydrogen in liquid ammonia at 0° and of nitrogen in liquid ammonia at 0° and 50° were measured at pressures ranging from 50 to 1,000 atmospheres.

Vapor pressure determinations were made for the two crystalline modifications of phosphorus pentoxide and for the liquid. The partial pressure of water vapor as a result of the dissociation of hydroxyapatite was found to be less than 1 atmosphere at 1,500° C. The structures of phosphorus trioxide and phosphorus pentoxide were determined by electron diffraction. The citrate-soluble materials formed when phosphate rock is calcined were found to be alphatricalcium phosphate, silico-carnotite, and a compound having the approximate composition, $3Ca_3(PO_4)_2.2Ca_2SiO_4$. When these materials are annealed in an atmosphere of steam below 1,200°, reversion to citrate-insoluble forms that have the structure of apatite takes place in many instances, but they are resolubilized with formation of the initial phases on reheating at 1,400° in an atmosphere of steam.

Work in cooperation with the Bureau of Entomology and Plant Quarantine showed that all calcium arsenate samples known to injure the foliage of apple trees contained dicalcium arsenate dihydrate. In cooperative work with the Bureau of Plant Industry to determine the effects of X-radiation on the history of corn smut, dosages of 100,000 R units were found to produce a distortion of the promycelium and to reduce greatly the number of sporidae, although these were normal in appearance. Extension of the investigations conducted with the latter Bureau on the effect of X-rays on corn seeds and tobacco plants, mentioned last year, disclosed that the delayed killing observed for corn occurred also with tomatoes, wheat, buckwheat, and pigweed, and that the germination of rice was stopped by a dosage greater than 35,000 R units.

Infrared absorption spectra characteristic of nitrous acid and nitric acid molecules have been found, that allow a quantitative study of the nitrous acid equilibrium and give promise of contributing directly to the elucidation of the structure of the nitrous acid molecule. In cooperation with the Bureau

of Standards, the infrared absorption spectra of a series of hydrocarbons having high molecular weights were determined.

The mass-spectrographic investigation of the abundance ratio of potassium isotopes in nature showed that bone marrow is high in the heavy isotope and that heart muscles are low in the radioactive isotopes.

NITROGENOUS FERTILIZER MATERIALS

In continuation of previously reported work for the purpose of combining inorganic nitrogen with waste organic materials to obtain products containing organic nitrogen, it was found that, in varying the ratios of ammonia to peat over a range from 0.1 to 2.0, the maximum amount of soluble nitrogen and the highest activity for the insoluble nitrogen were obtained with a ratio of 0.3 or 0.4. Peat samples ammoniated at 130° C. under 500 to 600 pounds pressure, with 40 percent of water and a ratio of ammonia to peat of 0.3 or 0.4, gave products which, in a series of pot tests, gave yields of carrots equaling those obtained with urea and cottonseed meal. The total nitrogen in the products was about 6 percent, and chemical tests showed relatively high activity for the insoluble nitrogen, of which 33 to 40 percent nitrified in the soil in 8 weeks.

In connection with the studies on ammoniation, it was found that treatment of dicyanodiamide with liquid ammonia at 155° C. resulted in a 75- to 80-percent conversion to melamine, a compound that contains about 68 percent of nitrogen. The nitrate, sulphate, and phosphate salts of this compound were prepared. Preliminary water-culture tests for their plant-food value gave results that were encouraging, but later similar tests and pot tests threw considerable doubt on the value of the melamine nitrogen as a plant food.

Preliminary studies on the hygroscopicities of the compounds of urea with magnesium sulphate and with magnesium nitrate, mentioned in last year's report, indicate that the compound with magnesium nitrate is very hygroscopic, and the compounds with magnesium sulphate much less so. The addition of 2 to 4 percent of driers such as calcium carbonate or oxide and magnesium oxide, improved the properties so that the sulphate compounds withstood humidities of 75 to 80 percent without caking. In similar experimental work on crystalline urea, no drier was found to be entirely satisfactory for reducing its caking tendency. An addition of 2 to 4 percent of lime proved most effective for this purpose.

BIOCHEMICAL AND ORGANIC NITROGEN INVESTIGATIONS

In studies of nitrogen fixation with additional strains of *Azotobacter*, conducted similarly to the studies with *A. vinelandii*, previously reported, a particularly interesting strain was found that was very low in nitrogen content and formed ammonia very slowly on the elimination of carbohydrate. The optimum temperature for its growth was higher, and its rate of growth was faster than in the other strains tested, and it preferred free rather than fixed nitrogen. In further experimental work, dealing with the effect of molybdenum on *Azotobacter*, nitrogen fixation was shown to be increased by this catalyst from 100 to 500 percent, depending on the strain of *Azotobacter* used. The molybdenum had no appreciable effect on the utilization of several fixed nitrogen compounds tested, which indicates that it serves as a catalyst in the fixation process itself, entirely apart from growth.

An extensive series of experiments was completed, in which an attempt was made to determine the conditions under which the root nodules of legumes may excrete nitrogen into the sand or soil, in which they are growing. With possibly one exception, no such nitrogen excretion was obtained. The results, therefore, like those of the preliminary studies mentioned last year, failed to confirm the findings of a Finnish worker who has repeatedly reported large excretions of aspartic acid and another unidentified nitrogen compound. Although these experiments do not disprove that the root nodules of legumes excrete nitrogen under some conditions, they show that heavy excretion of nitrogenous compounds does not always occur under good growing conditions.

A number of pure culture studies with the blue-green alga, *Nostoc muscorum*, previously isolated from the soil, showed that this organism fixes nitrogen from tenfold to twentyfold more rapidly than the few nitrogen-fixing blue-green algae previously studied by various workers, as high as 10 mg of nitrogen being fixed in 45 days per 100 cc of culture medium containing no carbohydrate. Nitrogen fixation also takes place slowly in the dark if a suitable source of

energy, such as glucose, is supplied. Details of growth conditions, such as composition of the medium, need for calcium and magnesium and various trace elements, and optimum light intensity, were determined. The studies indicate this organism to be of considerable economic importance in soils, since it adds both nitrogen and organic matter.

The composition of *Azotobacter vinelandii* was found to vary markedly when it was grown under different conditions; for example, if the only form of nutrient is atmospheric nitrogen the anhydrous bacteria contained 7.1 percent of nitrogen, 12.7 of lipid matter, and 4 of wax, as compared with 10.7 percent of nitrogen, 7.3 of lipid matter, and 10 of wax when grown on urea. Azotobacter nucleic acid prepared from organisms grown on atmospheric nitrogen was hydrolyzed under various conditions to isolate and identify its components; the bases present were cystosine, uracil, adenine, and guanine, and the carbohydrate proved to be ribose.

In a continuation of work on fixing nitrogen by reaction with organic substances apart from life processes, certain reactive unsaturated groupings were found to be reduced by 9-hydroxy- and 9-amino-fluorene derivatives in the presence of such catalysts as alkali or organic bases. Thus, azobenzene is converted to hydrazobenzene and dibiphenylene ethylene to the ethane derivative, whereas diazofluorene is reduced in two different ways, fluorene and nitrogen being formed in one reaction and fluorenone hydrazone in the other.

PHOSPHATES

Since the chemistry of defluorinated phosphates, such as calcined phosphate and fused phosphate rock, involves compounds about which little or no information is available, a study was initiated of the system $Ca_3P_2O_8$–CaO–SiO_2–H_2O at temperatures up to 1,500° C. When synthetic mixtures that fall within the range of composition of commercial phosphate rock were heated at 1,400°, the citrate-soluble compounds formed corresponded to those found in calcined phosphates obtained by heating phosphate rock in the presence of steam to 1,400°. At 1,400° the tricalcium phosphate forms an extensive series of solid solutions with calcium orthosilicate, and the silicocarnotite also forms solid solutions with the tricalcium phosphate.

A study of the boron content of natural phosphates showed that this element occurs in small quantities in phosphate rock from deposits throughout the world. In 40 samples of domestic phosphate rock, the content of acid-soluble boron trioxide ranged from less than 10 to 144 parts per million. In general, phosphate rock also contains acid-insoluble boron.

Investigations were continued on the factors affecting the reversion of the citrate-soluble phosphorus of calcined phosphate to the citrate-insoluble condition at temperatures below 1,400° C. The degree of reversion varies with the nature of the furnace atmosphere, the temperature at which the calcined phosphate is annealed, and the chemical composition of the calcined phosphate. It was found that calcined phosphates can be divided into three general classes, namely, (1) those that undergo no marked reversion in either a moist or a dry atmosphere, (2) those that show marked reversion in a wet atmosphere only, and (3) those that suffer marked reversion in both wet and dry atmospheres. When reversion takes place in both wet and dry atmospheres, it is usually much greater in the former. Reversion may occur throughout the temperature range of 200° to 1,300°, but it usually is greatest from 700° to 1,250°. The reverted phosphorus can be transformed into the citrate-soluble condition by reheating the material for a few minutes to 1,400° and cooling the product quickly. Although reversion of the phosphorus occurs very rapidly under laboratory conditions, examination of a number of samples prepared on a semicommercial scale indicated that reversion will not be a serious factor in the manufacture of the material. Reversion to the citrate-insoluble form is accompanied by the formation of phosphates that have an apatitelike structure.

Further studies on the plant-food value of calcined phosphate, in cooperation with a number of State experiment stations, indicated, in general, that the material, when ground to pass a 40-mesh sieve, is as effective per unit of P_2O_5 as superphosphate in promoting the growth of plants in neutral and acid soils, but it appears to be slightly less effective when applied to highly alkaline, calcareous soils. The phosphorus in reverted calcined phosphate is somewhat less available to plants than is the phosphorus in the rapidly cooled, unreverted product.

Pot tests with fused phosphate rock, which is similar to calcined phosphate in its chemical and physical properties, and calcium metaphosphate indicated that,

in general, these materials are good sources of phosphorus for plant growth. The importance of removing water-soluble compounds prior to the determination of citrate-insoluble phosphorus in fertilizers was demonstrated.

Preliminary experiments on the fixation of organic and inorganic phosphates from water solutions by soils indicate that the amount of organic phosphate removed from the solution varies with the soil used, the pH of the solution, and the time of contact. A soil high in colloidal matter, such as Cecil clay, removes the major portion of the inorganic as well as organic phosphate whereas a soil low in colloids, such as Norfolk loam, removes very little of either when the time of contact is only a few days. The quantity of organic phosphate removed from a water solution by Norfolk loam increases considerably as the time of contact is lengthened. In determinations by standard fertilizer methods of the amounts of organic phosphate fixed by soil, several widely different kinds of water-soluble organic phosphates were found to be entirely fixed by the soil used in the experiments.

POTASH SALTS AND BYPRODUCTS

Work has been continued on the utilization of dilute nitrosyl chloride gas, a byproduct obtained in the preparation of potassium nitrate by direct treatment of solid potassium chloride with gaseous nitrogen oxides produced by the oxidation of ammonia with air. Experiments on the absorption of this gas by moist phosphate rock for the production of available phosphates have shown that chlorine and nitrogen are absorbed by rock-water mixtures containing up to 50 percent of water in approximately the ratio of 2 mols of chlorine to one of nitrogen for nitrosyl chloride concentrations of about 4 percent. Because of the difficulty in maintaining fresh absorption surfaces with these mixtures, absorption ceased before complete decomposition of the rock was obtained. With larger proportions of water present, practically complete decomposition of the rock was obtained, but there was almost no preferential absorption of chlorine. In all instances the products obtained required drying. In some instances the removal of comparatively large amounts of water was necessary to produce a fertilizer material of satisfactory physical properties.

In further work on the preparation of potassium metaphosphate, a prospective fertilizer material that analyzes 40 percent of K_2O and 60 percent of P_2O_5, equimolal mixtures of potassium chloride and phosphoric acid were heated at various temperatures up to 900° C. The formation of the metaphosphate was favored by the higher temperatures, and the water-soluble portions of the product were found to contain unreacted chloride, together with phosphate in ortho, meta, and pyro forms. A product prepared from a commercial muriate that contained small amounts of sodium and sulphate impurities was found to contain 41 percent of its potash in water-soluble form. Products prepared similarly from reagent quality materials were practically insoluble. Aqueous solutions of sodium metaphosphate were found to exert a solvent effect on potassium metaphosphate and, in some instances, to result in thick viscous solutions which were remarkable because they contained less than 3 percent of total solids. Solutions of normal viscosity, however, were obtained by dissolving a fused mixture of sodium and potassium metaphosphates. The existence of potassium metaphosphate in one glassy and two crystalline forms was confirmed. The glassy form is water soluble and is the most difficult to prepare. It was obtained only by exceedingly rapid cooling of molten metaphosphate. With less rapid cooling, the metaphosphate crystallized in an insoluble form. The other crystalline form is water soluble and was obtained by neutralization and low-temperature evaporation of a solution of metaphosphoric acid.

In efforts to utilize the hydrochloric acid obtained as a byproduct when potassium chloride is converted into other potash salts, it was discovered about 2 years ago that this acid reacts with phosphate rock to form monocalcium chlorophosphate. Continued studies on this new compound showed that it is the product of a second-order reaction between calcium chloride and phosphoric acid, in which one-half of the chlorine in the calcium chloride is evolved as hydrochloric acid. Macroscopic crystals of monocalcium chlorophosphate sufficiently large for petrographic determination were obtained by evaporating and digesting at the boiling point aqueous, alcoholic, and glacial acetic acid solutions of calcium chloride and phosphoric acid. Similar procedures with barium chloride-phosphoric acid and magnesium chloride-phosphoric acid solutions failed to yield the analogous barium and magnesium salts. Monocalcium chlorophosphate undergoes both hydrolysis and solution in contact with water and alcohol. When treated with aqua ammonia or ammonia gas it is readily

ammoniated, and, because its citrate solubility is decreased only slightly, it is presumed that it forms ammonium chloride and dicalcium phosphate. On heating to 500° C. it decomposes to calcium pyrophosphate, losing both hydrochloric acid and water.

Vegetative tests on potassium metaphosphate and monocalcium chlorophosphate have shown both to be promising new fertilizer materials.

MIXED-FERTILIZER TECHNOLOGY

In continuation of the investigations on the granulation of fertilizer mixtures and materials, studies were made of the effects of temperature and moisture content on the granulation of 260 mixtures and individual materials and also of the effect of variations in particle size of the initial materials on the efficiency of the granulating process. Mixtures that consisted largely of inorganic materials were found to granulate more readily and with a lower moisture content than mixtures that were comparatively high in organic materials. Determinations of particle size previous to the granulation of mixtures and materials showed that the efficiency of granulation was reduced from 89 to 74 percent when the proportion of initial material that passed a 40-mesh screen was reduced from 100 to 50 percent. Finely divided materials were found to granulate easily, regardless of whether they were soluble or insoluble. As a rule, the presence of a soluble salt in a mixture tended to increase the crushing strength of the granule. Some easily soluble, readily fusible materials, such as urea and ammonium nitrate, were particularly effective in promoting granulation because of the cohesiveness they exhibited.

A variation of the rotary-drum granulating method, described in last year's report, was developed, wherein the desired moisture content and temperature were attained by the addition of steam to the mixture during the granulating step. The heat, necessary to facilitate granulation, may also be supplied by ammoniating the mixture during the granulation process, the heat developed in this way being sufficient in some instances to elevate the temperature to 100° C. and evaporate some of the moisture present.

In connection with the investigations to determine the effect of fertilizer mixtures and salts on the concentration of the soil solution and thus obtain information on the burning effects of the fertilizers on plants, it was found that when single- and double-strength fertilizers containing similar salts were applied at equivalent rates to the soils employed (Norfolk sandy loam and Cecil clay loam) the double-strength fertilizer had less effect than the single-strength materials in raising the concentration of the soil solution. However, when two double-strength mixtures containing dissimilar salts were applied, the mixture containing more soluble salt had the greater effect on the concentration of the soil solution. A 6–8–4 mixture prepared according to present manufacturing practice was found to have less effect than the 3–8–4 mixtures formerly used. The results indicate that from the point of view of injury to the crop through burning, it is no longer necessary to apply nitrogen to cotton in split applications. When granulated and powdered fertilizers of identical composition were applied to Norfolk sandy loam and Cecil clay loam, the soil solutions from the soils treated with the granulated mixtures had slightly lower concentrations than those from the soils treated with the powdered mixtures.

Determinations were made of the heats of reaction between a superphosphate (made from a Tennessee phosphate rock) and various quantities of anhydrous ammonia ranging from 1 to 10 percent, of the specific heats of a number of fertilizer materials, and of the heat of formation of monocalcium phosphate, for the purpose of ascertaining the maximum temperature rise that might occur in the ammoniation of various fertilizer mixtures. The heats of reaction found by experiment were in good agreement with the calculated values for the heats of reaction in the ammoniation of superphosphate and superphosphate mixtures. Confirmation was thus obtained of the reactions that were assumed to take place during ammoniation.

In further studies to determine the cause of reversion of the phosphoric acid in commercial ammoniated fertilizer mixtures that contain dolomite, a series of synthetic ammoniated mixtures were prepared, from which one or more of the impurities normally occurring in commercial superphosphate were eliminated in turn. It was found that reversion occurred in fluorine-free mixtures as well as in those that contained fluorine.

Fertilizer samples, representative of the mixed fertilizers consumed in the United States, were analyzed for all the common elements. Work is in progress on the determination of the trace elements in these samples.

The substitution of calcium metaphosphate for ordinary or double superphosphate in a fertilizer mixture was found to cause increased hygroscopicity of the mixtures. Mixtures containing crude calcium metaphosphate caked badly. Admixtures of calcined phosphate to salt pairs did not increase their hygroscopicity and did not have a retarding effect on the absorption of water by urea. Granulated urea was found to absorb moisture at about the same rate as does crystalline urea.

SOIL CHEMISTRY AND PHYSICS RESEARCH

SELENIUM IN SOILS

Further investigations were made on the occurrence of selenium in soils. Highly seleniferous areas were found in New Mexico and Colorado. A detailed examination of the soils in southeastern Colorado revealed the existence of a soil area in excess of 3,000 square miles, which is capable of producing vegetation toxic to animals. A similar but less extensive area was discovered in northeastern New Mexico. Investigation of the occurrence of selenium in semiarid areas was continued southward into Mexico during the winter. Domestic-animal and human symptoms indicated the presence of highly seleniferous areas in certain parts of Mexico.

Observations on the plants growing in seleniferous areas led to the inference that the occurrence of selenium in the soil influences the relative abundance of different plant species and perhaps even determines the presence of certain species.

Evidence was obtained that irrigated seleniferous soils produce vegetation of much lower selenium content than similar nonirrigated areas, provided sufficient selenium-free water is used.

A study of many soil profiles in seleniferous areas showed no constant relation in the distribution of the selenium within the soil profile and no constant relation between the selenium in any part of the soil profile and that of vegetation produced on it.

In connection with the identification of injuriously seleniferous areas, it has been necessary to ascertain whether the poisonous effects of selenium compounds on vegetation are influenced by the character of the soil. Sodium selenate is highly toxic to many crop plants, although a few plants are rather tolerant of it. In pot experiments 1½ parts of selenium as sodium selenate in a million parts of soil were found sufficient to reduce the growth of millet by 50 percent. Toxicity of the selenate varied little in soils of widely different character with regard to soil colloids, but it was less in those of high soluble sulphate content than in those of low sulphate content. Preliminary studies on sodium selenite, another form in which selenium occurs in soils, indicated that its behavior would be decidedly different from that of the selenate.

Data obtained by this Bureau in its selenium investigations have been employed by the Resettlement Administration in efforts to determine the most satisfactory uses for extensive seleniferous lands acquired by that organization in South Dakota.

NONFERTILE SOILS

Soils from the vicinity of barite areas in four States were found to contain from 0.1 to 3.69 percent of barium calculated as the oxide. A high percentage of barium apparently does not cause soil to be nonfertile when a sufficient quantity of lime is present, but it may be one of the causes of infertility in soils of low lime content. The maximum quantity of barium oxide found in plants grown on barium-containing soils was 0.15 percent.

Analyses of the leaves of trees growing on soils of different composition showed that the ash composition of the leaves and the composition of the soil are dependent on each other. Black locust leaves growing on limestone soil contained three times as much lime as the same kind of leaves growing on a lime-poor Podzol soil. The quantity of alumina and manganese found in leaves depends mainly on the soil reaction and not on the quantities of these elements in the soil, except when they are present in limiting quantities.

Certain leaves when grown on acid soils have been found to contain such a high percentage of alumina as to greatly affect the distribution of alumina in the soil profile. In pure stands of hickory and sweetleaf, the leaves of which contain, respectively, 1.5 and 4.5 percent of alumina, as much as 100 pounds of alumina per acre may be brought up from within the soil and deposited on its surface each year. The quantity of manganese in the leaves of trees grown

in very acid soils reaches a maximum of nearly 0.5 percent and thus becomes a major element in the ash composition of the leaves. The distribution of manganese in the soil profile must be affected to a marked extent by such a high percentage in the leaf litter.

Leaves of trees growing on soils of low lime content may be so low in lime as to form an acid litter which decomposes slowly and forms a mat that persists and accumulates, resulting in Podzol soils when climatic conditions are favorable. Hemlock needles and pine needles are particularly low in lime, and for this reason and perhaps others, hasten the podzolizing action as compared to the leaves of hardwood trees.

POORLY DRAINED SOILS

A study of soils formed under different conditions of drainage on the Atlantic Coastal Plain showed that the chemical composition of the colloids in poorly drained soils is fairly constant, approximating very closely the theoretical composition of halloysitic acid ($3H_2O.Al_2O_3,2SiO_2$). The colloids of all the coastal plain soils were low in bases but were lowest in the most poorly drained soils. The amount of eluviation was found to increase with the degree of drainage.

ALLUVIAL SOILS

A field study was made and samples collected of alluvial soils from the bottom lands of the following rivers: Mississippi (lower, middle, and upper), Black, Ohio, Tennessee, Cumberland, Duck, and Clinch. Since these soils show but slight profile development, they were sampled at such depths as to obtain material most representative of assumed A, B, and C horizons. At one place in the middle Mississippi area, 11 soil samples were obtained at various depths, ranging from the surface of the ground to the depth of the coastal plain material—100 feet. Fourteen samples of sedimentary material deposited by the January 1937 flood of the Ohio River were obtained for study.

LIMESTONE SOILS

Investigation of the limestone soils of the Great Valley was continued with a study of Lebanon silt loam from Phelps County, Mo., and of Hagerstown silt loam from St. Francois County, Mo. These soils, all derived from residual material from the decomposition of limestone, range from the Hagerstown which is typically a Gray-Brown Podzolic soil, through intermediate soils to the red soils of the Decatur series. The major variations in composition of the colloids involve the following elements: Iron, manganese, phosphorus, and the bases. Silica and alumina do not vary through a wide range.

GRANITIC SOILS

Samples of profiles of soils from New England and the Piedmont, derived from granitic material, were collected and studied with respect to composition and the chemical and physical properties of their colloids. The results of this study showed that the podzolization process has kept pace with the disintegration of rock and has been extremely active in the formation of colloids of the Gray-Brown Podzolic soils derived from glacial drift. Podzolization is slight in the same group of soils developed on the comparatively ancient formations. The dominant soil-forming process of each group is hydrolysis; it is influenced by the parent material and is intensified by an increase in the mean annual temperature. Environmental conditions tend to produce, in the soils of New England and the Piedmont, colloids of a wide range in composition. Parent material, temperature, rainfall, and vegetation are the primary factors affecting the composition of the colloids.

MOISTURE IN SOILS

For studying the relative moisture-retaining capacities of different soils and the problem of why and how some soils hold more moisture than others, determinations of the exact temperatures at which soils freeze and thaw and the quantities of heat released or absorbed in these changes of state have been found very useful. Measurement of the changes in dielectric constant of soils was found to be an accurate means for obtaining data relative to their freezing and thawing. During the year an apparatus was designed and constructed for this purpose. Results obtained by the use of this apparatus showed that in the lower range of moisture content, at least, soils begin to freeze and are

completely thawed at the same temperature, indicating no wetting and drying hysteresis at this temperature.

The same apparatus and method were found to be useful in determining the temperature and time required to freeze vegetables and fruits and other materials.

ADSORPTION OF GASES BY SOILS

In order to gain further insight into the surface relationships in soils, a study is being made of the behavior of soils and their colloids with respect to adsorption of gases. Special apparatus for this purpose was constructed with the aid of P. H. Emmett of the Fertilizer Research Division. Experimental data have been obtained on the adsorption of nitrogen at 0° and —183° C., of oxygen at 0°, and of carbon dioxide at 0°, by soil and colloid samples of single horizons representative of five great soil groups. The adsorption values found for the soils were used to calculate the percentage of colloidal material present, and the calculated values agreed reasonably well with those obtained by mechanical analysis. An attempt is being made to use the adsorption isotherm for nitrogen at —183° C., to estimate surface areas and to correlate the magnitudes thus obtained with known chemical and physical properties of soils and soil colloids. The magnitude of the adsorption of individual gases differs for soils of various great soil groups and is lower for the soils than for their corresponding colloids. Each soil and colloid has a characteristic adsorption value which is correlated with the general classification of soils.

The density of the various soil materials used in this work was obtained by a new modification of the usual pyknometer method. Helium was used instead of a liquid to fill the pyknometer space, thus assuring a complete penetration of the pores of the solid and eliminating the possibility of any chemical or physical reactions.

STRUCTURE OF PEAT

The colloidal material in the organic matter of peats is being studied, with particular reference to its dispersibility and the base combining capacity of its acids.

The segregation of colloidal peat acids by a purely mechanical dispersion procedure, such as is used in the case of mineral soils, was not found possible. Even the use of such drastic hydraulic agitation as given by a colloid mill proved inadequate. A system of fractionation by chemical means was employed for the separation of colloidal and other acids. This consisted of a preliminary electrodialysis followed by treatment with 1-percent solution of sodium hydroxide at 70° to 75° C. The material dispersed to colloidal size as well as that dissolved by the alkaline treatment was separated by means of a supercentrifuge and subsequent filtration.

A method of electrometric titration of peats and peat fractions was developed. In this method a fairly definite end point was consistently indicated by breaks in the titration curve at pH values of approximately 7.2 to 8.8. The success of this method of titration is based on the use of a very dilute suspension and a time reaction of from 8 to 10 days before making pH measurements. The peat fractions differed widely with respect to the relative amounts of base required for neutralization. As much as 70 percent of the total acidity of the original peat was found in the so-called humic-acid fraction which was the material dissolved by the alkaline solution and precipitated by acid. The base-combining capacities of a number of entire peat samples were found to vary from approximately 2.5 to 3.5 milliequivalents of barium per gram of peat.

QUICK CHEMICAL TESTS FOR SOILS

Comparative results have been obtained by various quick tests on widely divergent soils. These tests are believed to be of very limited usefulness in the hands of an untrained person, except as he may wish to conduct local soil experiments. They are of greater value to agronomists who have good background of supplemental information. Chemical tests may be of marked value to one who has knowledge concerning the general level of chemical values obtained for soils of some particular series, their productivity with various fertilizer treatments, and their suitability for particular crops, and they may be very helpful for the detection of overfertilization in special instances, as with greenhouse soils.

SOIL REACTION

During the last 11 years a large number of hydrogen-ion concentration determinations have been made on soils from all parts of the United States, including samples of profiles from all the major soil groups and most of the more important soil series. Work has been started on the organization of these voluminous data into form for publication. The data are adequate to show, in general, the maximum and minimum pH values, as well as the predominating values characteristic of the various soil groups and soil series of this country.

SERVICE WORK

Chemical and mechanical analyses of soils, as well as certain other physical tests including the determination of moisture equivalent, are made in considerable numbers. During the last year, the service work included 145 complete chemical analyses of soils and soil colloids, 1,331 nitrogen determinations, and 732 mechanical analyses of soils. Many of the mechanical analyses were made for the Soil Survey Division and for the Federal Emergency Administration of Public Works, and numerous miscellaneous tests were made for the Soil Conservation Service.

SOIL SURVEY

The work of the Soil Survey Division comprises the determination of the character of soils, definition of soil types, development of a uniform system of soil classification, delineation upon maps of the boundaries of each soil type, and the interpretation of the capabilities of the soils for the production of crops, grasses, and trees under different kinds of management. The ultimate purpose of this research is to provide accurate soil maps of the country which are necessary for the classification of rural lands, and for the factual basis in the development of rational programs of land use, consistent with conservation and the welfare of the agricultural people, whether planned by public agencies or individual farmers.

During the year, 27,350 square miles of rural lands in 33 States and Hawaii were mapped by the Soil Survey Division. This brings the total area covered by the soil survey to more than one-half of the arable lands of the Nation. The soil maps, together with the accompanying reports giving descriptions of the soils and their uses, provide farmers, research workers, extension leaders, and local officials with a practical working handbook of the land for the area covered. In order that the results of experiments on farm land may be utilized in connection with problems of land use, it is necessary that information be given regarding the type of soil on which the experiments are made. Once an accurate map of the soil types is made, the results may be extended to individual farm areas having the same soil types. The continued extension in the use of soil maps, wherever they are available, for determining land-use policies testify to their accuracy and value.

STATE COOPERATION

All this research is accomplished in direct cooperation with local agencies, especially the State agricultural experiment stations. In this way both the broader perspective of the Federal organization and the more detailed local knowledge of the State agencies are utilized to the best advantage, each supplementing the other. For example, the Bureau is cooperating with the seven States having responsibilities for the programs of agricultural development in the watershed of the Tennessee River. The agricultural experiment stations of these States also are cooperating with the Tennessee Valley Authority in expediting the completion of the detailed soil survey of that area and in conducting research on the various soil types in order to determine their capabilities for agricultural use. Accurate detailed maps showing the location of the various soil types having particular possibilities for use under different types of management are essential in developing systems of agriculture, offering security to the farm family, and for improvement of the land, prevention of erosion, and the protection of streams and reservoirs.

Similarly, the Bureau is cooperating with a great many other States in order to obtain the information essential to a solution of their land-use problems. In several of the Western States, such as California, Oregon, Utah, Washington, and others, information on soils is essential for planning the extension of certain special crops and for the proper planning or extension

of irrigation, in order to avoid areas subject to an accumulation of alkali or those having excessive water requirements or other draw-backs.

The problems in each State, and even in each county, are more or less individualistic and require somewhat different approach for their solution. This fact emphasizes the necessity of cooperation among Federal, State, and local people in order that a balanced point of view may be obtained. The soil maps are made in such a way as to indicate those physical differences in the land which determine or influence its capabilities for use. Usually an area has more than one problem; the soil map must carry the physical information pertinent to them all. Thus, from the soil map, other relatively simple maps, showing only one characteristic, may be made by interpretation. For example, supplemental maps showing only erodibility, lime requirement, drainage, or similar features can be made from the soil map. Others may be prepared, showing relatively simple groups of soils according to their adaptability to alfalfa, tree fruits, or other crops or groups of crops. Using the soil map as the base, other maps may be prepared, showing the general suitability of the land for agricultural or other uses as a means for developing plans for rural zoning. All these relatively simple maps would differ from one another, although each would be taken from the master soil map. In North Dakota, for example, soil maps are used as the basis for rating rural land for tax assessments.

REGIONAL INVESTIGATIONS

Since it is of the utmost importance that the nomenclature of soil types, their definitions, and classification be everywhere consistent, regional comparisons of soil types are essential to the general program. These activities are conducted by the supervisory scientists of the Bureau, who are responsible also for the nomenclature used on the detailed soil maps. During the year special regional studies have been made in the western part of the country, where the present information is inadequate for the proper conduct of more detailed surveys.

PRODUCTIVITY RATING

A system is being developed rapidly for relating the results of experience and experiments to the individual soil types (and phases), in order that each soil shown on the map may be given a definite rating according to its productivity and crop adaptability. Such a system involves consideration of the inherent productivity of the soil as well as its productivity under different systems of management. Many of the soil surveys being published currently contain tables showing these productivity ratings, and it is expected that this research will be pushed to the point where such tables will accompany all soil surveys as soon as the system is broadened and fully developed.

PREPARATION OF SOIL MAPS

After the soil maps have been drawn in the field and the necessary description of the soils and their capabilities for use prepared, the maps are redrawn for publication, and the reports, including soil descriptions, recommendations for their use, agricultural statistics and similar matters, are printed. These reports and maps generally are published in county units, although occasionally the unit of publication is more or less than one county, such as a stream valley or a watershed. When completed the reports and maps are made available to the public and to all Government agencies having need for them.

The progress of soil mapping is shown in tables 1 and 2, and a list of soil surveys published during the last year is included with the list of publications.

TABLE 1.—*Individual areas surveyed and mapped during the fiscal year ended June 30, 1937*

State or Territory	Area	Area surveyed	
		Square miles	*Acres*
Alabama	Lee County	[1] 188	120,320
	Macon County	[1] 478	305,920
Arizona	Yuma-Gila area	114	72,960
California	Bakersfield area	1,120	716,800
Colorado	Kings County	290	185,600
	Washington County	[1] 605	387,200

[1] These figures do not include portions of these areas surveyed in preceding years.

TABLE 1.—*Individual areas surveyed and mapped during the fiscal year ended June 30, 1937*—Continued

State or Territory	Area	Area surveyed	
		Square miles	*Acres*
Florida	Alachua County	229	146,560
Georgia	Catoosa County	169	108,160
	Hall County	[1] 59	37,760
Hawaii	Hawaiian Islands	[1] 1,969	1,260,160
Idaho	Bingham County	[1] 249	159,360
Indiana	Brown County	[1] 272	174,080
	Fulton County	47	30,080
	Johnson County	41	26,240
	Martin County	339	216,960
	Morgan County	27	17,280
Iowa	Allamakee County	[1] 154	98,560
	Jackson County	[1] 104	66,560
	Story County	[1] 183	117,120
	Tama County	318	203,520
Kentucky	Calloway County	[1] 170	108,800
Maine	York County	278	177,920
Michigan	Clinton County	[1] 324	207,360
	Mason County	[1] 220	140,800
	Newaygo County	30	19,200
Minnesota	Washington County	153	97,920
Mississippi	Tishomingo County	[1] 225	144,000
Nebraska	Cass County	[1] 302	193,280
	Cherry County	[1] 908	581,120
	Lancaster County	[1] 94	60,160
	Otoe County	36	23,040
New Hampshire	Cheshire County	400	256,000
	Coos County	1,053	673,920
	Sullivan County	[1] 277	177,280
New York	Albany-Schenectady Counties	[1] 48	30,720
	Niagara County	[1] 178	113,920
	Sullivan County	232	148,480
North Carolina	Henderson County	[1] 75	48,000
	Jackson County	43	27,520
	Madison County	[1] 189	120,960
	Swain County	343	219,520
	Transylvania County	169	108,160
	Warren County	[1] 115	73,600
North Dakota	Morton County	[1] 317	202,880
	Williams County	209	133,760
Ohio	Tuscarawas County	[1] 132	84,480
Oklahoma	Choctaw County	[1] 487	311,680
	Creek County	[1] 170	108,800
	Woods County	399	255,360
Oregon	Baker County	27	17,280
	Umatilla area	[1] 256	163,840
Pennsylvania	Bucks County	[1] 69	44,160
	Crawford County	221	141,440
	Fayette County	36	23,040
Rhode Island	Newport-Bristol Counties	[1] 32	20,480
	Providence County	199	127,360
South Carolina	Pickens County	[1] 172	110,080
Tennessee	Bedford County	35	22,400
	Cumberland County	253	161,920
	Hamilton County	[1] 268	171,520
	Humphreys County	[1] 107	68,480
	Lincoln County	[1] 291	186,240
	Roane County	[1] 123	78,720
Texas	Brown County	[1] 90	57,600
	Dimmit County	369	236,160
	Fannin County	[1] 236	151,040
Utah	Provo-Lehi area	119	76,160
Virginia	Isle of Wight County	[1] 98	62,720
	Princess Anne County	56	35,840
	Russell County	[1] 407	260,480
	Smyth County	89	56,960
	Tazewell County	107	68,480
	Washington County	[1] 280	179,200
Washington	Clallam County	53	33,920
	King County	33	21,120
	Kittitas County	[1] 195	124,800
	Snohomish County	[1] 545	348,800
	Yakima County	[1] 180	115,200
West Virginia	Greenbrier County	[1] 431	275,840
Wyoming	Campbell County	[1] 2,205	1,411,200
Total		22,113	14,152,320

[1] These figures do not include portions of these areas surveyed in preceding years.

TABLE 2.—*Areas surveyed and mapped in the several States during the fiscal year ended June 30, 1937, and the areas previously reported*

DETAILED

State or Territory	Work during 1937	Work previously reported	Total	
	Square miles	*Square miles*	*Square miles*	*Acres*
Alabama	666	59,836	60,502	38,721,280
Arizona	114	4,955	5,069	3,244,160
Arkansas		15,547	15,547	9,950,080
California	1,410	38,562	39,972	25,582,080
Colorado	605	6,128	6,733	4,309,120
Connecticut		1,704	1,704	1,090,560
Delaware		2,276	2,276	1,456,640
Florida	229	15,160	15,389	9,848,960
Georgia	228	36,452	36,680	23,475,200
Hawaii	1,969	699	2,668	1,707,520
Idaho	249	12,716	12,965	8,297,600
Illinois		6,770	6,770	4,332,800
Indiana	726	21,645	22,371	14,317,440
Iowa	759	51,445	52,204	33,410,560
Kansas		16,854	16,854	10,786,560
Kentucky	170	5,784	5,954	3,810,560
Louisiana		17,431	17,431	11,155,840
Maine	278	2,197	2,475	1,584,000
Maryland		13,959	13,959	8,933,760
Massachusetts		8,811	8,811	5,639,040
Michigan	574	32,693	33,267	21,290,880
Minnesota	153	12,867	13,020	8,332,800
Mississippi	225	30,943	31,168	19,947,520
Missouri		37,177	37,177	23,793,280
Montana		3,287	3,287	2,103,680
Nebraska	1,340	69,108	70,448	45,086,720
Nevada		652	652	417,280
New Hampshire	1,730	3,390	5,120	3,276,800
New Jersey		9,895	9,895	6,332,800
New Mexico		2,565	2,565	1,641,600
New York	458	37,535	37,993	24,315,520
North Carolina	934	48,809	49,743	31,835,520
North Dakota	526	22,523	23,049	14,751,360
Ohio	132	18,650	18,782	12,020,480
Oklahoma	1,056	25,283	26,339	16,856,960
Oregon	283	15,991	16,274	10,415,360
Pennsylvania	326	22,689	23,015	14,729,600
Puerto Rico		3,765	3,765	2,409,600
Rhode Island	231	1,690	1,921	1,229,440
South Carolina	172	27,082	27,254	17,442,560
South Dakota		8,286	8,286	5,303,040
Tennessee	1,077	12,687	13,764	8,808,960
Texas	695	66,730	67,425	43,152,000
Utah	119	3,096	3,215	2,057,600
Vermont		1,175	1,175	752,000
Virginia	1,037	15,498	16,535	10,582,400
Washington	1,006	12,388	13,394	8,572,160
West Virginia	431	23,904	24,335	15,574,400
Wisconsin		26,659	26,659	17,061,760
Wyoming	2,205	12,582	14,787	9,463,680
Total	22,113	948,530	970,643	621,211,520

RECONNAISSANCE

Alaska		31,915	31,915	20,425,600
Arkansas-Missouri		58,000	58,000	37,120,000
California		32,135	32,135	20,566,400
Kansas		39,960	39,960	25,574,400
Michigan		1,322	1,322	846,080
Minnesota	433	12,311	12,744	8,156,160
Montana	2,935	51,943	54,878	35,121,920
Nebraska		53,064	53,064	33,960,960
North Dakota		39,240	39,240	25,113,600
Ohio		41,420	41,420	26,508,800
Pennsylvania		41,405	41,405	26,499,200
South Dakota		41,400	41,400	26,496,000
Texas		152,855	152,855	97,827,200
Vermont		9,124	9,124	5,839,360
Washington	1,869	16,540	18,409	11,781,760
Wisconsin		14,425	14,425	9,232,000
Total	5,237	637,059	642,296	411,069,440

SPECIAL WORK OF THE SOIL SURVEY

For the successful prosecution of many of the activities of the Federal Government and cooperating State agencies it has been necessary for scientists in the Soil Survey Division to interpret the available soil data in terms of the particular objective at hand. As the soil-survey data are fundamental and basic for almost all kinds of agricultural activities, thousands of private individuals and organizations, as well as public agencies, seek the advice and assistance of soil scientists of the Bureau as to the location of soil types adaptable to various crops and how the various soil types may be managed. Requests of this kind have greatly increased in the last few years.

For many years scientists in the Soil Survey Division have called attention to the serious injury, through erosion, to soils when they are improperly used. The fundamental nature of the soil type determines its erodibility under different methods of management. The soil maps serve as a basis for erosion surveys and erosion-control projects. In many instances where these maps have been unavailable, soil scientists of this Bureau have assisted in making special studies and maps for the use of Federal and State agencies charged with the responsibilities for the control of erosion. Scientists of the Bureau are assisting the Tennessee Valley Authority, Soil Conservation Service, and other agencies toward this end.

In addition to the attention given to the possibilities of land for irrigation in connection with the regular soil-survey projects, special reports have been prepared in regard to the suitability of land for irrigation in areas under the jurisdiction of other governmental agencies.

Work has been continued in the investigation of peat lands in cooperation with other Federal and State agencies, particularly from the point of view of the relationship of such soils to the conservation of land and prevention of floods. A special report describing the characteristics and distribution of various kinds of organic soils and peat in the Pacific Coast States has been published. Special studies and reports have been made of peat areas in connection with the work of the Bureau of Biological Survey and other agencies having special problems in the utilization of these lands.

The Soil Survey Division has continued to assist in the selenium investigations being carried on by the Department. Examinations of soils and vegetation in several States, where excess selenium in the soil is an important factor in their utilization, have been made. The results of these researches are incorporated in reports published by the Bureau.

Land appraisers of the Farm Credit Administration and other agencies have made wise use of the soil-survey maps and reports. Through personal contact and in other ways, scientists on the Soil Survey Division staff have assisted in the interpretation of soil data as they bear on land appraisal of rural lands affected by flood-control projects.

INFORMATION AND PUBLICATIONS

During the year, Department publications from this Bureau were 26 soil-survey reports, 7 technical bulletins, 1 circular, 3 miscellaneous publications, 3 articles in the Journal of Agricultural Research, 15 mimeographed publications, 205 articles in outside publications, and 14 patents. In cooperation with the press and radio services, the Bureau furnished information on various phases of its research.

The following lists show the publications and patents from the nine research divisions of this Bureau:

LIST OF PUBLICATIONS

CARBOHYDRATE RESEARCH DIVISION

Apparent and true solids of sugarcane juice—relation of difference to ash content. By C. A. Fort and N. McKaig, Jr. Indus. and Engin. Chem., Analyt. Ed. 8: 333–335. 1936. (With Bur. Plant Indus.)

Report of studies on uniformity of quality of sugars. I. Chemical studies of beet sugars collected during 1935 campaign. By J. C. Keane, S. Byall, and J. A. Ambler. 17 pp. 1936. [Mimeographed.]

Report of studies on uniformity of quality of sugars. I. Chemical studies of beet sugars collected during 1936 campaign. By J. C. Keane, S. Byall, and R. M. Kingsbury. 19 pp. 1937. [Mimeographed.]

Impurities in white sugars. IX. Loss of anions from certain salts during evaporation of concentrated sugar solutions. By J. A. Ambler. Indus. and Engin. Chem. 28: 1266–1268. 1936.

Recent advances in the technology of beet sugar manufacture. By J. C. Keane and

H. S. Paine. Special issue of Facts about Sugar. A Century of Sugar Beets In the United States. pp. 27–29. 1937.

Yield and quality of table sirup from fresh cut vs. old-cut sugarcane. By C. F. Walton, Jr., and C. A. Fort. Sugar Bull. 14 (22): 6–7. 1936.

Quality of table sirup from the newer sugarcane varieties. By C. F. Walton, Jr., and C. A. Fort. Sugar Bull. 15 (3): 4–6. 1936.

Food plants of the North American Indians. By E. Yanovsky. U. S. Dept. Agr. Misc. Pub. 237.

The mineral constituents of honey. By R. E. Lothrop. Gleanings Bee Cult. 64 (8): 469–471; Amer. Bee Jour. 76 (7): 346–347; Bees and Honey 17 (10): 343–345. 1936.

Adulteration of honey is readily detected by present highly perfected methods. By R. E. Lothrop. Gleanings Bee Cult. 64 (7): 397–399; Amer. Bee Jour. 76 (8): 396–397. 1936.

Honey utilization and marketing. By R. E. Lothrop. Amer. Bee Jour. 76 (12): 583. 1936.

On filtering honey—a reply to Mr. Fernes. By H. S. Paine and R. E. Lothrop. Gleanings Bee Cult. 65 (1): 17. 1937.

Ability of honey to absorb and retain moisture, and practical applications of this and other properties to promote greater use of honey. By R. E. Lothrop. Beekeepers Item 21 (2): 62–68. 1937.

Starch and other products from sweetpotatoes. By H. S. Paine. South. Chemurgic Conf. Condensed Proc. 69: 107–112. 1936

Sweetpotato starch—a new farm industry for the south. By H. G. Knight. Manfr. Rec. 56 (2): 40–41 and 68. 1937.

New uses for sweetpotatoes bring new opportunities for southern farmers. By H. G. Knight. South. Agr. 67 (2): 5 and 41. 1937.

The centenary of the beet sugar industry in the United States. By C. A. Browne. Special issue of Facts about Sugar. A Century of Sugar Beets in the United States. pp. 12–16. 1937.

Photoelectric grading of white sugars and their solutions by reflectance and transmittancy measurements. By J. C. Keane and B. A. Brice. Indus. and Engin. Chem Analyt. Ed. 9: 258–263. 1937. (With Food and Drug Admin.)

The normal weight question in the analysis of sugar factory products. By C. A Browne. Internatl. Soc. Sugar Cane Technol. Proc. (1935) 5: 830–832. 1936.

The keeping qualities of sugarcane molasses. By C. A. Browne. Internatl. Soc. Sugar Cane Technol. Proc. (1935) 5: 216–227. 1936.

Composition of the oil of the American black walnut. By G. S. Jamieson and R. S McKinney. Oil and Soap 13 (8): 202. 1936.

Expressed kapok seed oil. By G. S. Jamieson and R. S. McKinney. Oil and Soap 13 (9): 233–234. 1936.

A non-fatty oil from jojoba seed. By R. S. McKinney and G. S. Jamieson. Oil and Soap 13 (11): 289–292. 1936

Japanese tung oil. By R. S. McKinney and G. S. Jamieson. Oil and Soap 14 (1): 2–3. 1937.

Soybean phosphatides. By R. S. McKinney, G. S. Jamieson, and W B. Holton. Oil and Soap 14 (5): 126–129. 1937. (With Amer. Univ.)

CHEMICAL ENGINEERING RESEARCH DIVISION

Losses of organic substance in the spontaneous heating of alfalfa hay. By E. J. Hoffman and M. A. Bradshaw. Jour. Agr. Research 54: 159–184. 1937.

Explosion at consolidated school, New London, Tex.—Report on investigation of explosion at consolidated school, New London, Tex., March 18, 1937. By D. J. Price. 75th Cong., 1st sess., S. Doc. 56, 13 pp. 1937. (Presented by Senator Tom Connally, of Texas.)

How dust explosions can occur while firemen are fighting fires. By D. J. Price. Va. Fireman, p. 8. July 1936.

Stop cotton gin fires. By H. G. Knight. South. Agr. 66 (9): 11, 19. 1936.

Dust explosion prevention in soybean processing plants. By D. J. Price. Amer. Soybean Assoc. Proc., pp. 40–45. 1936.

Some observations on the spontaneous heating and ignition of hay. By H. E. Roethe. 7 pp. 1936. [Mimeographed.]

Hay fires. By H. E. Roethe. (Abstract.) Safety Engin. 73 (1): 47. 1937.

Prevention of silo gas accidents. By D. J. Price, H. E. Roethe, and M. A. Bradshaw. (Presented at meeting of Amer. Soc. Agr. Engin. Dec. 1, 1936.) 6 pp. [Mimeographed.] Agr. Engin. 18 (3): 104–106, 1937; Hazards on the farm. Safety Engin. 72 (6): 28. 1936; Warns of asphyxiation hazard in silos. Natl. Safety News 35 (1): 71. 1937; Silo gas accidents. Weekly Underwriter 136 (1): 4; Mutual Ins. Bull. pp. 17–22. 1937.

Developments in dust explosion prevention in industrial plants. By D. J. Price. 7 pp. 1936. [Mimeographed.] Dust explosion prevention in industrial plants. Weekly Underwriter, pp. 1363–1365. December 5, 1936.

Explosion and fire prevention research as related to the fire service. By D. J. Price. 7 pp. 1937. [Mimeographed.] Monetary Times 98: 34. 1937. Toronto, Canada.

Some observations on farm fire protection. By H. E. Roethe. 6 pp. 1937. [Mimeographed.] Minutes 41st Ann. Conv. Mutual Ins. Cos. Union Ind., pp. 23–30. 1937.

Reduce our cotton fire loss. By H. R. Brown. Cotton and Cotton Oil Press 38 (13): 46–47. 1937.

Recent developments in dust explosion prevention in industrial plants. By D. J. Price. 15 pp. 1937. [Mimeographed.] Important observations as to dust explosions. Natl. Underwriter, p. 2. Apr. 8, 1937.

Dust explosions in industrial plants. By D. J. Price. Va. Fireman, p. 2. March 1937.

Results of recent investigations on the spontaneous heating and ignition of hay. By H. E. Roethe. 9 pp. 1937. [Mimeographed.]

Dust explosion prevention. By D. J Price and H. R. Brown. Safety Engin. 73 (1): 45–46; The Fireman 60 (725): 108. 1937.

Dr. Price recommends steps to cut dust explosion risks for firemen. By D. J. Price. Fire Engin. 90 (2): 81. 1937.

FERTILIZER RESEARCH DIVISION

The nuclear separation of the S_2 molecule by electron diffraction. By L. R. Maxwell, V. M. Mosley, and S. B. Hendricks. Phys. Rev. 50: 41–45. 1936.

The theoretical calculation of the distribution of photochemically-formed ozone in the atmosphere. By O. R. Wulf and L. S. Deming. Jour. Terrestrial Magnetism and Atmospheric Electricity 41: 299–310. 1936.

Filament sources of positive ions. By J. P. Blewett and E. J. Jones. Phys. Rev. 50: 464–468. 1936. (With Princeton Univ.)

Organic microanalysis. I. Nitrogen by Dumas method. By R. T. Milner and M. S. Sherman. Indus. and Engin. Chem., Analyt. Ed. 8: 331–332. 1936.

Crystal structure of polonium by electron diffraction. By M. A. Rollier, S. B. Hendricks, and L. R. Maxwell. Jour. Chem. Phys. 4: 648–652. 1936. (With Milan Univ.)

The system magnesium sulfate-urea-water at 30° C. By C. W. Whittaker, F. O. Lundstrom, and J. H. Shimp. Jour. Amer. Chem. Soc. 58: 1975–1978. 1936.

Hydrogen bond formation between hydroxyl groups and nitrogen atoms in some organic compounds. By S. B. Hendricks, O. R. Wulf, G. E. Hilbert, and U Liddel, Jour. Amer. Chem. Soc. 58: 1991–1996. 1936.

Concerning beta-2, 3, 4, 6-tetraacetyl-d-glucose. By S. B. Hendricks, O. R. Wulf, and U. Liddel. Jour. Amer. Chem. Soc. 58: 1997–1999 1936.

Criteria of chemical mechanism in nitrogen fixation by living forms. By D. Burk. 2d Internatl. Cong. Microbiol. Abs. pp. 147–148; Rept. of 2d Microbiol. Cong. London, Proc. pp. 264–265. 1936.

The extent to which chemical research has lowered the cost of fertilizers to consumers since 1880. By A. L. Mehring and L. S. Deming. Amer. Fert. 85: 7–11 and 18–22. 1936.

The effect of ortho substitution on the absorption of the OH group of phenol in the infra-red. By O. R. Wulf, U. Liddel, and S. B. Hendricks. Jour. Amer. Chem. Soc. 58: 2287–2293. 1936.

Organic microanalysis. II. Drying and analysis of hygroscopic substances. By R. T. Milner and M. S. Sherman. Indus. and Engin. Chem., Analyt. Ed. 8: 427–428. 1936.

An adjustable sensitive thermoregulator. By J. Y. Yee and R. O. E. Davis. Indus. and Engin. Chem., Analyt. Ed. 8: 477. 1936.

What the southern farmer pays for the filler in his fertilizer. By A. L. Mehring. Com. Fert. Yearbook, pp. 21–28. 1936.

Factors affecting the determination of available phosphorus in calcined phosphate and other water-insoluble phosphates By K. D. Jacob, L. F. Rader, and T. H. Tremearne. Jour. Assoc. Off. Agr. Chem. 19: 449–472. 1936.

Monocalcium chlorophosphate. I. Reaction product of calcium chloride and phosphoric acid. By E. J. Fox and K. G. Clark. (Abstract) Amer. Fert. 85 (6): 6. 1936.

Phosphate rock. By K. D. Jacob. Mineral Indus. 44: 452–466 1936.

Experiments on the diffusion of nitrogenous compounds from healthy legume nodules or roots. By C. A. Ludwig and F. E Allison. (Abstract) Jour. Bact. 31: 93–94. 1936.

The stimulation of Rhizobia by natural humic acid. By F. E. Allison and S. R. Hoover. (Abstract) Jour. Bact. 31: 94–95. 1936.

Equipment for growing plants in nitrogen fixation studies. By C. A. Ludwig. Bot. Gaz. 98 (4): 670–679. 1937.

Experiments concerning diffsion of nitrogenous compounds from healthy legume nodules or roots. By C. A. Ludwig and F. E. Allison. Bot. Gaz. 98 (4): 680–695. 1937.

Heterocyclic compounds. By G. E. Hilbert. Ann. Survey Amer. Chem. (1935) (14): 205–217. 1936.

The effect of visible solar radiation on the calculated distribution of atmospheric ozone. By O. R. Wulf and L. S. Deming. Jour. Terrestrial Magnetism and Atmospheric Electricity 41 (4): 375–378. 1936

Concerning the crystal structure of kaolinite $Al_2O_3.2SiO_2.2H_2O$, and the composition of ananxite. By S. B. Hendricks. Ztschr. Kristallographie 95: 247–252. 1936.

Chemical reactions in fertilizer mixtures. Effect of ammoniation on the urea component of superphosphate mixtures. By F. O. Lundstrom and C. W. Whittaker. Indus. and Engin. Chem. 29: 61–68. 1937. (Abstract in Amer. Fert. 85 (6): 6–7. 1936.)

Synthesis of 1-d-ribosidouracil, Interaction of acetebromo-d-ribose and 2, 4-dicthoxypyrimidine. By G. E. Hilbert and C. E. Rist. Jour. Biol. Chem. 117: 371–380. 1937.

Melamine of possible plant food value. By W. Scholl, R. O. E. Davis, B. E. Brown, and F. R. Reid. Indus. and Engin. Chem. 29: 202–205. 1937. (With Bur. Plant Indus.)

A method for the synthesis of phenanthridine derivatives by an application of the Stieglitz rearrangement. By L. A. Pinck, and G. E. Hilbert. Jour. Amer. Chem. Soc. 59: 8–13. 1937.

Concerning the alleged absorption of gaseous nitrogen by benzene solutions of rubber and guttapercha hydrocarbons. By L. B. Howard and G. E. Hilbert. Jour. Amer. Chem. Soc. 59: 214–215. 1937.

Accumulation of alkali promoters on surfaces of iron synthetic ammonia catalysts. By P. H. Emmett and S. Brunauer. Jour. Amer. Chem. Soc. 59: 311–315. 1937.

Synthetic nucleosides—some 1-glycosidouracils. By G. E. Hilbert. Jour. Amer. Chem. Soc. 59: 330–333. 1937.

Determination of urea nitrogen in fertilizer mixtures. By J. Y. Yee and R. O. E. Davis. Jour. Assoc. Off. Agr. Chem. 20: 104–107. 1937.

Potassium nitrate from potassium chloride and nitrogen peroxide. By D. L. Reed and K. G. Clark. Indus. and Engin. Chem. 29: 333–336. 1937. (Abstract in Amer. Fert. 85 (6): 6. 1936.)

Double compounds of urea with magnesium nitrate and magnesium sulphate. By J. Y. Yee, R. O. E. Davis, and S. B. Hendricks. Jour. Amer. Chem. Soc. 59: 570–571. 1937.

Designing soft copper gaskets for high pressure equipment. By W. L. Edwards. Chem. and Metall. Engin. 44: 134–137. 1937.

Physiological studies with the nitrogen-fixing alga, *Nostoc muscorum*. By F. E. Allison, S. R. Hoover, and H. L. Morris. Bot. Gaz. 98 (3): 433–463. 1937. (With Food and Drug Admin.)

Abundance ratio of the isotopes of potassium in animal tissues. By A. K. Brewer. Jour. Amer. Chem. Soc. 59: 869–872. 1937.

The vapor pressure of phosphorus pentoxide. By J. C. Southard and R. A. Nelson. Jour. Amer. Chem. Soc. 59: 911–916. 1937.

Chemical reactions in fertilizer mixtures. Reactions of diammonium phosphate with limestone and with dolomite. By K. C. Beeson. Indus. and Engin. Chem. 29: 705–708. 1937.

The mechanism of delayed killing of maize seedlings with X-radiation. By L. R. Maxwell. Phys. Rev. 51: 375. 1937.

The nuclear separation of Te_2 molecule by electron diffraction. By L. R. Maxwell and V. M. Mosley. Phys. Rev. 51: 684. 1937.

Interatomic distances of the alkali halides. By L. R. Maxwell, S. B. Hendricks, and V. M. Mosley. (Abstract) Bull. Amer. Phys. Soc. 12: 8. 1937.

The crystal structure of alunite and the jarosites. By S. B. Hendricks. Amer. Mineralogist 22 (6): 773–785. 1937.

Influence of fertilizers on the concentration of the soil solution. By L. M. White and W. H. Ross. Soil Sci. Soc. Amer. Proc. 1: 181–186. 1937.

The role of traces of molybdenum in the physiology and agrobiology of azotobacter. By D. Burk and C. K. Horner. Soil Sci. Soc. Amer. Proc. 1: 213–214. 1937.

Blast-furnace processes for the production of phosphatic and potassic fertilizer materials. By P. H. Royster and others. U. S. Dept. Agr. Tech. Bull. 543.

On the significant figures of least squares and correlations. By W. E. Deming. Science 85: 451–454. 1937.

The one-tenth percent level of "Z." By C. G. Colcord and L. S. Deming. Sankhya: The Indian Jour. Statis. 2 (4): 423–424. 1936.

The granulation of fertilizer mixtures. By W. H. Ross and J. O. Hardesty. Com. Fert. Yearbook, pp. 28–34. 1937.

Chemical fertilizers. By A. R. Merz. Technological Trends and National Policy. Natl. Resources Com., pp. 123–125. June 1937.

An estimation of the atomic weights of lithium, potassium, and rubidium from isotope abundance measurements. By A. K. Brewer. (Abstract) Phys. Rev. 49: 967. 1936.

On the significance of parameters. By W. E. Deming. Phys. Rev. 49: 857–858. 1936.

Review of "An outline of probability and its uses. By M. C. Holmes." By W. E. Deming. Jour. Amer. Statis. Assoc. 31: 622–623. 1936.

Recent applications of electron diffraction to molecular structures. By L. R. Maxwell. (Abstract) Jour. Wash. Acad. Sci. 26: 475. 1936.

Review of "Catalytic reactions at high pressures and temperatures. By C. N. Ipatieff." By P. H. Emmett. Indus. and Engin. Chem., News Ed. 28: 477. 1936.

On the biochemical mechanism of nitrogen fixation by living forms. By D. Burk. Biochimica 2 (1): 312–329. 1937.

The distribution of atmospheric ozone in equilibrium with solar radiation and the rate of maintenance of the distribution. By O. R. Wulf and L. S. Deming. Jour. Terrestrial Magnetism and Atmospheric Electricity 42 (2): 195–202. 1937.

Report of the joint committee of the Association of Land-Grant Colleges and Universities and of the Department of Agriculture on the conservation and use of our national phosphate resources for the permanent benefit of the American people. 27 pp. 1936. [Mimeographed.]

The use of adsorption isotherms for measuring the surface areas of catalysts and other finely divided materials. By P. H. Emmett and S. Brunauer. Electrochem. Soc. Trans. 71: 383–395. 1937.

Effect of removing water-soluble compounds prior to the determination of citrate-soluble phosphorus in fertilizers. By K. D. Jacob and T. H. Tremearne. Jour. Assoc. Off. Agr. Chem. 20: 277–287. 1937.

Report on phosphoric acid availability of calcined phosphate and other phosphatic materials as determined by chemical and vegetative tests. By W. H. Ross and K. D. Jacob. Jour. Assoc. Off. Agr. Chem. 20: 231–249. 1937.

Filler in relation to plant food units. By A. L. Mehring. 3 pp. 1936. [Mimeographed.]

Production and agricultural use of sodium nitrate. By A. R. Merz. U. S. Dept. Agr. Circ. 436.

FOOD RESEARCH DIVISION

Research promises valuable Florida citrus by-products. By H. W. von Loesecke. Jacksonville Jour. p. 10. December 11, 1936.

Varietal suitability of cultivated highbush blueberries for freezing in consumer packages. By H. H. Moon, H. F. Smart, and J. S. Caldwell. Fruit Prod. Jour. 15 (8): 229–231, 248, 251. 1936. (With Bur. Plant Indus.)

Lima beans in frozen pack. By H. F. Smart and B. C. Brunstetter. Canner 83 (10): 14–16. 1936. (With Bur. Plant Indus.)

Spinach and kale in frozen pack. I. Scalding tests. H. Microbiological studies. By H. F. Smart and B. C. Brunstetter. Food Research 2 (2): 151–163. 1937. (With Bur. Plant Indus.)

Microbiology of frozen pack vegetables. By H. A. Berry. Western Canner and Packer 29 (4): 14–16. 1937.

Preservation of grape juice. IV. Pasteurization of juices or musts prepared from several varieties of grapes. By C. S. Pederson, E. A. Beavens, and H. E. Goresline. Food Research 1 (4): 325–335. 1936. (With N. Y. State Agr. Expt. Sta.)

New York champagnes. By H. E. Goresline and R. Wellington. Wines and Vines 17 (12): 5 and 19. 1936. (With N. Y. State Agr. Expt. Sta.)

Recent wine investigations. By H. E. Goresline. 2d Internatl. Cong. Microbiol., London, July 25–August 1, 1936, Proc. pp. 259–260. 1936.

Bottled wine pasteurization tests. By H. E. Goresline. Wine Rev. 5 (6): 19. 1937.

Cooperative research in wine making at Geneva, New York. By H. E. Goresline and D. K. Tressler. Amer. Wine and Liquor Jour. 5: 20, 32. 1937. (With N. Y. State Agr. Expt. Sta.)

Silver in the artificial aging of brandies. By E. A. Beavens, H. E. Goresline, and and E. K. Nelson. Indus. and Engin. Chem. 29: 623–625. 1937.

The flavor of alcoholic beverages. By E. K. Nelson and D. H. Wheeler. Food Research 2 (3): 221–226. 1937.

Wines, brandies, and cordials from citrus fruits. By H. W. von Loesecke, H. H. Mottern, and G. N. Pulley. Indus. and Engin. Chem. 28: 1224–1229. 1936.

Concentrated apple juice. By H. H. Mottern. Wash. State Hort. Assoc. Proc. 32: 114–118. 1936.

Dried egg white. By A. K. Balls and T. L. Swenson. Food Research 1 (4): 319–324. 1936.

Further studies on the activity of proteinase in flour. By A. K. Balls and W. S. Hale. (Abstract) Cereal Chem. 13 (6): 656–664. 1936.

Some wax-like constituents from expressed oil from the peel of Florida grapefruit, *Citrus grandis*. By K. S. Markley, E. K. Nelson, and M. S. Sherman. Jour. Biol. Chem. 118: 433–441. 1937.

Report on oil of peppermint. By E. K. Nelson. Jour. Assoc. Off. Agr. Chem. 19: 529–532. 1936.

Coloring matters of Grimes Golden, Jonathan, and Stayman Winesap apples. By C. E. Sando. Jour. Biol. Chem. 117: 45–56. 1937.

Chronic nicotine toxicity. I. Feeding of nicotine sulphate, tannate, and bentonite. By R. H. Wilson and F. DeEds. Jour. Indus. Hyg. and Toxicology 18: 553–564. 1936.

Chronic nicotine toxicity. II. The effect of nicotine-containing diets on the blood sugar concentration of the albino rat. By R. H. Wilson and F. DeEds. Jour. Indus. Hyg. and Toxicology 18: 565–570. 1936.

Nicotine toxicity. III. Effect of nicotine-containing diets on the estrus cycle. By R. H. Wilson and F. DeEds. Jour. Pharmacol. and Expt. Ther. 59 (3): 260–263. 1937.

Report of studies on uniformity of sugars. II. Report on biological studies of sugars. By H. H. Hall and L. H. James. 19 pp. 1936. [Mimeographed.]

Report of studies on uniformity of sugars. II. Report on biological studies of sugars. By H. H. Hall. 20 pp. 1937. [Mimeographed.]

Soybeans and soybean flour and the effect of storage conditions upon the composition of soybeans. By J. A. LeClerc and L. H. Bailey Amer. Soybean Assoc. Proc. 16: 16–20. 1936.

Report of the Department of Agriculture bread flavor committee. By F. B. King, D. A. Coleman, and J. A. LeClerc. Cereal Chem. 14 (1): 49–58. 1937. (With Burs. Home Econ. and Agr. Econ.)

Some observations on methods of ashing cereal products. By L. H. Bailey. Cereal Chem. 14 (1): 120–128. 1937.

A photoelectric method for the determination of phosphorus. By C. W. Eddy and F. DeEds. Indus. and Engin. Chem., Analyt. Ed. 9: 12–14. 1937.

By-products from apples and other fruits. By H. H. Mottern. Western Canner and Packer 29 (6): 12–15. 1937.

Report of the committee on testing rye flour. By L. H. Bailey. Cereal Chem. 13 (6): 770–772. 1936.

Toxicological study of derris. By A. M. Ambrose and H. B. Haag. Indus. and Engin. Chem. 28: 815–821. 1936.

The micro-determination of silicon. By F. DeEds and C. W. Eddy. Jour. Biol. Chem. 114: 667–672. 1936.

Report on enzymes. By A. K. Balls and W. S. Hale. Jour. Assoc. Off. Agr. Chem. 19: 372–373. 1936.

Photochemical studies of rancidity: Induction period of protected and non-protected oils. By M. R. Coe. Oil and Soap 13 (8): 197–199. 1936.

Solubility of naringin in water. By G. N. Pulley. Indus. and Engin. Chem., Analyt. Ed. 8: 360. 1936.

Soya flour. By J. A. LeClerc and L. H. Bailey. Amer. Soybean Assoc. Sup. to Proc. 8 pp. 1936.

The capacity of flattened tube juice pasteurization. By J. L. Heid and W. C. Scott. Fruit Prod. Jour. 16 (5): 136–139. 1937.

Undesirable color change in frozen peas stored at insufficiently low temperatures. By H. Campbell. Food Research 2 (1): 55–57. 1937.

Eggs—from hen to Henry. By W. W. Skinner. South. Agr. 67 (3): 5, 13, and 53. 1937.

Effect of ethylene for treatment of olives. By E. M. Chace and D. G. Sorber. Western Canner and Packer 29 (4): 41–42. 1937.

Toxicological studies of derris—comparative toxicity and elimination of some constituents of derris. By A. M. Ambrose and H. B. Haag. Indus. and Engin. Chem. 29: 429–431. 1937.

The work at citrus products station. By J. L. Heid. Tex. Farming and Citriculture 13 (11): 4 and 22. 1937.

Microorganisms causing fermentation flavors in cane sirups, especially Barbados "molasses." By H. H. Hall, L. H. James, and E. K. Nelson. Jour. Bact. 33: 577–585. 1937.

Notes on the oil-treatment of shell eggs as an adjunct to their cold storage. 2 pp. 1937. [Mimeographed.]

Partial list of references on wheat germ. By J. A. LeClerc. 4 pp. 1937. [Mimeographed.]

INDUSTRIAL FARM PRODUCTS RESEARCH DIVISION

The cost of manufacturing sodium chlorate. (Submitted by Chief of Bureau to House Appropriations Committee.) Prepared by P. H. Groggins, A. L. Pitman, J. McLaren, and F. H. Davis. 76 pp. 1937. [Mimeographed.]

Electrochemical production of sodium chlorate. By P. H. Groggins, A. L. Pitman, J. McLaren, and F. H. Davis. Chem. and Metall. Engin. 44: 302. 1937.

Pilot scale calfskin curing with treated salt. By R. W. Frey and L. S. Stuart. Jour. Amer. Leather Chem. Assoc. 31 (7): 254–263. 1936.

The effect of sodium chloride on the Eh of protogenous media. By L. S. Stuart and L. H. James. (Abstract) Jour. Bact. 33 (1): G24. 1937.

The effect of Eh and sodium chloride concentration on the physiology of halophilic bacteria. By L. S. Stuart and L. T. James. (Abstract) Jour. Bact. 33 (1): G29. 1937.

The saprophytic digestion of sterilized animal hair and keratose. By L. S. Stuart. Jour. Amer. Leather Chem. Assoc. 32 (6): 276–284. 1937.

Fluorine content of gelatin from calfskins cured with salt and fluorides. By L. S. Stuart, D. Dahle, and R. W. Frey. Jour. Amer. Leather Chem. Assoc. 32 (5): 205–210. 1937. (With Food and Drug Adm.)

Western hemlock bark an important potential tanning material. By C. C. Smoot and R. W. Frey. U. S. Dept. Agr. Tech. Bull. 566.

Comparative permanence of vegetable tanned leathers containing sodium chloride and sodium tartrate as indicated by gas chamber tests. By C. W. Beebe and R. W. Frey. Jour. Amer. Leather Chem. Assoc. 31 (9): 337–345. 1936.

The magenta series. II. Some higher basic members. By J. T. Scanlan. Jour. Amer. Chem. Soc. 58: 1427–1429. 1936.

Industrial utilization of farm products. By P. B. Jacobs. Natl. Resources Com. Technological Trends and National Policy, pp. 130–133. June 1937.

Some ketonimine dyes and related compounds. By J. D. Reid and D. F. J. Lynch. Jour. Amer. Chem. Soc. 58: 1430–1432. 1936.

The production of basic fuchsin suitable for the Feulgen technic. By J. T. Scanlan and C. G. Melin. Stain Technol. 12 (1): 1–8. 1937.

Translating mold fermentation research to pilot plant operations. By P. A. Wells, D. F. J. Lynch, H. T. Herrick, and O. E. May. Chem. and Metall. Engin. 44 (4): 188–190. 1937.

The production of gluconic acid by *Penicillium chrysogenum*. By A. J. Moyer, O. E. May, and H. T. Herrick. Zentbl. Bakt. [etc.] 95 (2): 311–324. 1936.

Rhizopus elegans Eidam. By L. B. Lockwood. Mycologia 28 (6): 542–545. 1936.

Biochemical studies in the genus *Rhizopus*. I. Production of dextro-lactic acid. By G. E. Ward, L. B. Lockwood, O. E. May, and H. T. Herrick. Jour. Amer. Chem. Soc. 58: 1286–1288. 1936.

The physiology of *Rhizopus oryzae*. By L. B. Lockwood, G. E. Ward, and O. E. May. Jour. Agr. Research 53: 849–857. 1936.

The ammoniation of waste sulphite liquor and its possible utilization as a fertilizer material. By M. Phillips, M. J. Goss,

B. E. Brown, and F. R. Reid. Jour. Agr. Research 53: 209–224. 1936. (With Bur. Plant Indus.)

The simultaneous quantitative estimation of the percentages methoxyl and ethoxyl groups in organic substances. By M. Phillips and M. J. Goss. Jour. Assoc. Off. Agr. Chem. 20 (2): 292–297. 1937.

Amination by ammonolysis: Effect of ammonia concentration. By P. H. Groggins and A. J. Stirton. Indus. and Engin. Chem. 28: 1051. 1936.

Recent progress in the application of the Friedel and Crafts reaction. By P. H. Groggins. Amerikanskaya Technica 14 (6): 251–256. 1937.

Processing soybeans for oil and meal. By O. E. May. 4 pp. 1936. [Mimeographed.]

Proposed research program of the Regional Soybean Industrial Products Laboratory. By O. E. May. Oil and Soap 13 (9): 229–231. 1936.

Research program of the Regional Soybean Industrial Products Laboratory. By O. E. May. Amer. Soybean Assoc. Proc. 16: 3–6. 1936.

The U. S. Regional Soybean Industrial Products Laboratory. By O. E. May. Midwestern Conf. Agr. Indus. and Sci. Condensed Proc. 76: 78–80. 1937.

Industrial utilization of farm products. By H. G. Knight. Midwestern Conf. Agr. Indus. and Sci. Condensed Proc. 76: 10–16. 1937.

Deterioration of book and record papers. By T. D. Jarrell, J. M. Hankins, and F. P. Veitch. U. S. Dept. Agr. Tech. Bull. 541.

Determination of volatile fatty acids by the partition method. By O. L. Osburn, H. G. Wood, and C. H. Werkman. Indus. and Engin. Chem., Analyt. Ed. 8: 270–275. 1936.

Utilization of farm wastes. By H. G. Knight. South. Chemurgic Conf. Condensed Proc. 69: 8–14. 1936.

Furfural information sheet. By H. D. Weihe. 8 pp. 1937. Revised [Mimeographed.]

Hydrogen-ion concentration and ascus formation. By L. B. Lockwood. Mycologia 29 (2): 289–290. 1937.

Gluconic acid production: Effect of pressure, air flow, and agitation on gluconic acid production by submerged mold growths. By P. A. Wells, A. J. Moyer, J. J. Stubbs, H. T. Herrick, and O. E. May. Indus. and Engin. Chem. 29: 653–656. 1937.

NAVAL STORES RESEARCH DIVISION

Cup and apron tests reported by U. S. Naval Stores Station. By F. P. Veitch and G. P. Shingler. Naval Stores Rev. 46 (46): 8; 47 (12): 14. 1937.

Rosin lost in chips, rock dross, and batting dross. By G. P. Shingler, C. K. Clark, and H. C. McConnell. 4 pp. 1937. [Mimeographed.]

Naval stores producers plan new season's work. By F. P. Veitch and C. F. Speh. Naval Stores Rev. 46 (45): 10. 1937.

Gathering and stilling scrape. By H. D. Cook. Naval Stores Rev. 46 (31): 10. 1936.

Still setting active in Florida. By H. D. Cook. Naval Stores Rev. 46 (49): 14. 1937.

A catalytic method for the preparation of alpha-d pyroabietic acid. By E. E. Fleck and S. Palkin. Science 85: 126. 1937.

Report on naval stores. By F. P. Veitch. Jour. Assoc. Off. Agr. Chem. 19: 390. 1936.

Markets for surplus production of naval stores. By C. F. Speh. Gulf Coast Chemurgic Conf. and the Tung Oil Assoc. Amer. Condensed Proc. 69: 159–163. 1936.

Naval stores greatest need—scientic research. By C. F. Speh. Fla. Chemurgic Conf. Condensed Proc. 57: 49–54. 1937.

1936–37 Semi-annual report on production, distribution, consumption, and stocks of turpentine and rosin. By F. P. Veitch and C. F. Speh. 10 pp. 1936. [Mimeographed.] Naval Stores Rev. 46 (35): 21. 1936.

1936–37 Annual report on production, distribution, consumption, and stocks of turpentine and rosin. By E. P. Veitch and C. F. Speh. 11 pp. 1937. [Mimeographed.] Naval Stores Rev. 47 (12): 8 and 13. 1937.

Turpentine farmers lose by not removing chips from gum. By G. P. Shingler, C. K. Clark, and H. C. McConnell. Naval Stores Rev. 47 (2): 14. 1937.

What's ahead in naval stores? By H. G. Knight. Manfrs. Rec. 105 (8): 34–35, 62. 1936.

PROTEIN AND NUTRITION RESEARCH DIVISION

Protein content of the bark of black locust, *Robinia pseudacacia*. By D. B. Jones and S. Phillips. Jour. Amer. Chem. Soc. 59 (3): 595–596. 1937.

Amino acids in staple foods. I. Wheat (*Triticum vulgare*.) By F. A. Csonka. Jour. Biol. Chem. 118: 147–153. 1937.

Amino acids in staple foods. II. The effect of milling wheat on the distribution of amino acids. By F. A. Csonka. Cereal Chem. 14 (3): 397–399. 1937.

The selenium and cystine content of some partial hydrolysis products of gluten from toxic wheat. By D. B. Jones, M. J. Horn, and C. E. F. Gersdorff. Cereal Chem. 14 (1): 130–134. 1937.

Some observations on food allergy. By H. Stevens. Oil and Soap 13 (7): 162–165. 1936.

Do feathers make you sick? By W. W. Skinner. Country Gent. 56 (9): 93 and 95. 1936.

Nitrogen determination in refractory substances. By J. R. Spies and T. H. Harris. Indus. and Engin. Chem., Analyt. Ed. 9: 304–306. 1937.

SOIL CHEMISTRY AND PHYSICS RESEARCH DIVISION

A note on mechanical analysis and soil texture. By T. M. Shaw and L. T. Alexander. Soil Sci. Soc. Amer. Proc. 1: 303–304. 1937.

Influence of drainage upon coastal-plain soils. By R. S. Holmes and H. G. Byers. Soil Sci. Soc. Amer. Proc. 1: 161–163. 1937.

Detection of freezing point by dielectric measurements. By L. T. Alexander, T. M. Shaw, and R. J. Muckenhirn. Soil Sci. Soc. Amer. Proc. 1: 113–119. 1937.

A method for determining ice-water relationships by measurements of dielectric constant changes. By L. T. Alexander and T. M. Shaw. Nature [London] 139 (3530): 1109–1110. 1937.

The behavior of lignin and humic acid preparations toward a bromination treatment. By I. C. Feustel and H. G. Byers. Soil Sci. 42 (1): 11–21. 1936.

The comparative moisture-absorbing and moisture-retaining capacities of peat and soil mixtures. By I. C. Feustel and H. G. Byers. U. S. Dept. Agr. Tech. Bull. 532. (Abstract in Soil Sci. Soc. Amer. Proc. 1: 323–325. 1937.)

Occurrence of selenium in soils of the United States with a discussion of related topics. Second Report. By H. G. Byers. U. S. Dept. Agr. Tech. Bull. 530.
Selenium in Hawaii and its probable source in the United States. By H. G. Byers, K. T. Williams, and H. W. Lakin. Indus. and Engin. Chem. 28: 821–823. 1936.
Selenium compounds in soils. By K. T. Williams and H. G. Byers. Indus. and Engin. Chem. 28: 912–914. 1936.
A report on the determination of selenium in soils. By K. T. Williams. Jour. Assoc. Off. Agr. Chem. 20 (2): 225–228. 1937.
Selenium and its relation to soils, plants, and animals. By K. T. Williams. Tabulae Biologica 14 (2): 194–208. 1937.
Neutralization curves of the colloids of soils representative of the great soil groups. By M. S. Anderson and H. G. Byers. U. S. Dept. Agr. Tech. Bull. 542. (Abstract in Amer. Soil Survey Assoc. Bull. 17, 173 pp. 1936.)
Variation of the soil colloids formed from similar parent material. By I. C. Brown and H. G. Byers. Soil Sci. Soc. Amer. Proc. 1: 171–173. 1937.
Some moisture relations of the soils from the erosion experiment stations. Fifth report. By L. B. Olmstead. Soil Sci. Soc. Amer. Proc. 1: 61–64. 1937.
Trace elements in the soils from the erosion experiment stations with supplementary data on other soils. By C. S. Slater, R. S. Holmes, and H. G. Byers. U. S. Dept. Agr. Tech. Bull. 552.
Comparison of various quick tests on different soils. By M. S. Anderson and W. M. Noble. U. S. Dept. Agr. Misc. Pub. 259.
Selenium and its relation to soils, plants, animals, and public health. By H. G. Knight. 9 pp. 1936. [Mimeographed.] Sigma Xi Quart. 25 (1): 1–9. 1937.

SOIL SURVEY DIVISION

Peat land in the service of flood control and water conservation. By A. P. Dachnowski-Stokes. Soil Sci. Soc. Amer. Proc. 1: 319–321. 1937.
Method of recording soil data. By C. C. Nikiforoff. Soil Sci. Soc. Amer. Proc. 1: 307–317. 1937.
A soil auger for dry soils. By R. C. Cole and J. L. Retzer. Soil Sci. Soc. Amer. Proc. 1: 305–306. 1937. (With Univ. Calif.)
Physical characteristics of the soil profile as applied to land classification. By T. D. Rice. Soil Sci. Soc. Amer. Proc. 1: 455–458. 1937.
Peat land in the Pacific Coast States in relation to land and water resources. By A. P. Dachnowski-Stokes. U. S. Dept. Agr. Misc. Pub. 248.
General trends of the desert type of soil formation. By C. C. Nikiforoff. Soil Sci. 43: 105–131. 1937.
The inversion of the great soil zones in western Washington. By C. C. Nikiforoff. Geogr. Rev. 27 (2): 200–215. 1937.
Soil and the people. By C. E. Kellogg. 6 pp. 1937. [Mimeographed.]
Soil: Its use and conservation. (First part Utilization.) By J. K. Ableiter. Natl. Resources Com., Technological Trends and National Policy, pp. 120–129. June 1937.
Some general aspects of Chernozem formation. By C. C. Nikiforoff. Soil Sci. Soc. Amer. Proc. 1: 333–342. 1937.
Soil work in Texas. By H. G. Knight. Farm and Ranch 55 (15): 3, 11. 1936.

SOIL SURVEYS

Alabama

Lauderdale County.
Mobile County.
Winston County.

California

Alturas area.
Lodi area.

Indiana

Randolph County.
Rush County.

Kentucky

Fayette County.

Michigan

Iron County.

Nebraska

Greeley County.
Rock County.

New Mexico

Roswell area.

New York

Broome County.
Rensselaer County.

North Carolina

Lee County.
Washington County.

Ohio

Brown County.
Putnam County.

Pennsylvania

Indiana County.

Texas

Cass County.
Falls County.
Hardeman County.
Wheeler County.

Vermont

Reconnaissance of State of Vermont.

Virginia

Augusta County.

West Virginia

Randolph County.

MISCELLANEOUS

A sketch of the life and chemical theories of Dr. Edward Bancroft. By C. A. Browne. Jour. Chem. Ed. 14: 103–107. 1937.
Fletcher Pearre Veitch. By W. W. Skinner. Indus. and Engin. Chem., News Ed. 14: 153–154. 1936.
Report of the chief of the Bureau of Chemistry and Soils, 1936 (for the fiscal year ended June 30, 1936).
Academies of science and the cooperative spirit in scientific research. By C. A. Browne. Science 84: 1–7. 1936.

UNITED STATES PUBLIC-SERVICE PATENTS

Gauge for measurement of gas pressures. By S. Palkin. U. S. Patent 2,051,740; August 18, 1936.

Turpentine dip barrel head lock and remover. By L. Evans. U. S. Patent 2,052,223; August 25, 1936.

Process for removing fibrous layers (wall paper) from surfaces (plaster). By M. Leatherman. U. S. Patent 2,052,884; September 1, 1936.

Process for the alteration of egg white. By A. K. Balls and T. L. Swenson. U. S. Patent 2,054,213; September 15, 1936.

Apparatus for deaerating liquids. By G. N. Pulley. U. S. Patent 2,060,242; November 10, 1936.

Process for the alteration of egg white. By A. K. Balls and T. L. Swenson. U. S. Patent 2,062,387; December 1, 1936.

Composition for removing fibrous layers from surfaces. By M. Leatherman. U. S. Patent 2,067,326; January 12, 1937.

Composition for removing fibrous layers from surfaces. By M. Leatherman. U. S. Patent 2,067,327; January 12, 1937.

Process for purification of extracted honey. By R. E. Lothrop and H. S. Paine. U. S. Patent 2,070,171; February 9, 1937.

Process of producing thin egg white. By A. K. Balls and T. L. Swenson. U. S. Patent 2,073,411: March 9, 1937.

Molecular addition compound of calcium sulphate and urea. By C. W. Whittaker and F. O. Lundstrom. U. S. Patent 2,074,880; March 23, 1937.

Fire-extinguishing compositions. By J. O. Reed. U. S. Patent 2,074,938; March 23, 1937.

Emulsifying agents (sapogenin). By C. E. Sando. U. S. Patent 2,076,794; April 13, 1937.

Process of inducing uniformity of blooming and fruit production in fruiting plants. By D. G. Sorber and M. H. Kimball. U. S. Patent 2,084,461; June 22, 1937.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D.C. - - - - - - Price 10 cents

REPORT OF THE CHIEF OF THE COMMODITY EXCHANGE ADMINISTRATION, 1937

United States Department of Agriculture,
Commodity Exchange Administration,
Washington, D. C., September 18, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I submit herewith a report of the work of the Commodity Exchange Administration for the fiscal year ended June 30, 1937.

Sincerely yours,

J. W. T. Duvel, *Chief.*

CONTENTS

INTRODUCTION

Trading in commodity futures, aggregating approximately $25,000,000,000 annually, was placed under the jurisdiction of the Commodity Exchange Administration by the enactment of the Commodity Exchange Act on June 15, 1936. During the 12 months which have elapsed since that date, rapid strides have been taken to enforce the provisions of that act. Its vigorous enforcement is essential to the orderly marketing of American agricultural products and consequently is of direct concern to every farm family in the United States.

Inasmuch as trading in commodity futures has always been surrounded with a certain amount of mystery in the public mind, brief summary statements are included in this report covering the development of the system of futures trading, its economic value, its extent and characteristics, together with a description of the activities of the Administration during the past 12 months.

Grain futures transactions originated in Chicago prior to the Civil War as an outgrowth of dealing in time contracts. These time contracts involved the sale of grain for deferred delivery and were recorded as early as 1848. Inasmuch as it required 6 weeks for information concerning grain prices in Liverpool to reach Chicago the ownership of these time contracts was attended with considerable risk. Speculation therein reached vast proportions during the Civil War,

and in 1865 the rules of the Chicago Board of Trade recognized trading in grain futures as a distinct commercial practice. Trading in cotton futures on the New York Cotton Exchange followed in 1870.

As a result of erratic price fluctuations associated with the widespread trading in futures contracts, dissatisfaction developed among producers and others which, by 1884, resulted in the introduction of a bill in the United States House of Representatives designed to combat manipulation and market corners. By 1921 more than 200 bills providing for the prohibition, supervision, or regulation of trading in commodity futures on organized exchanges had been introduced in Congress. The result was the enactment in 1921 of the Futures Trading Act, grounded on the taxing power of Congress, which provided a limited measure of supervision of trading in grain futures. This law was short lived, however, as its principal provisions, with one exception, were declared an invalid exercise of the taxing power in the case of *Hill* v. *Wallace* (259 U. S. 44) decided by the Supreme Court on May 15, 1922. This decision was followed by the prompt enactment of the Grain Futures Act on September 21, 1922, virtually identical with the invalidated Futures Trading Act but predicated upon the commerce clause of the Constitution. The constitutionality of The Grain Futures Act was upheld by the Supreme Court on April 16, 1923, in the case of *Board of Trade* v. *Olsen* (262 U. S. 1). On June 15, 1936, this act was amended and extended to cover other commodities and its short title changed to Commodity Exchange Act.

PRINCIPAL PROVISIONS OF GRAIN FUTURES ACT

The original Grain Futures Act contained a finding by Congress that transactions in grain futures are affected with a national public interest; that prices of grain futures on exchanges are susceptible to speculation, manipulation, and control as a result of which sudden or unreasonable price fluctuations frequently occur. These facts were declared to constitute a burden upon interstate commerce and to render Federal regulation imperative. The act restricted transactions in grain futures to such boards of trade (exchanges) as should be designated contract markets by the Secretary of Agriculture pursuant to application and upon a showing that the applicant exchange complied with certain prescribed requirements and conditions relating to (1) location and conditions under which cash grain is sold, (2) the filing of reports showing the details of all cash-grain and grain futures transactions of its members, (3) the prevention of dissemination of false or misleading crop or market information, (4) the prevention of manipulation of prices or the cornering of grain, (5) the admission of financially responsible farmers' cooperative associations, and (6) the making effective of orders denying trading privileges to persons found by the commission created by the act to have violated certain provisions of the act or the regulations thereunder.

The Grain Futures Act empowered the Commission, consisting of the Secretary of Agriculture, chairman; the Attorney General; and the Secretary of Commerce, to suspend or revoke the contract-market designation of an exchange upon showing that it had failed to comply with any of the above requirements or was not enforcing its rules of government. It authorized the Secretary of Agriculture, should he have reason to believe that any person is violating the act, or is attempting to manipulate the market price of any grain, to require such person to show cause why he should not be denied all trading priivileges on all contract markets. The act also authorized the Secretary to make such investigations as he might deem necessary to ascertain the facts regarding the operations of boards of trade and to publish the results of such investigations and such statistical information as he might deem of interest to the public. Trading in grain futures on or subject to the rules of any board of trade not duly designated as a contract market as well as knowingly delivering for transmission through the mails or in interstate commerce false or misleading or knowingly inaccurate reports concerning crop or market information or conditions tending to affect the price of grain in interstate commerce was declared a misdemeanor subject to $10,000 fine, or imprisonment for not more than 1 year, or both.

The Grain Futures Act was drafted largely with the idea of enabling the Government to deal with the exchanges, themselves, rather than with individual traders. It enabled the Grain Futures Administration to serve as a fact-finding organization, the results of its various investigations being made available for the information of Congress and the public. The limitations of the act as an adequate regulatory measure, however, were soon recognized, and bills to strengthen and reinforce it were first introduced during the 1927–28 session of the Seventieth Congress. No action was taken, however, until 1936.

COMMODITY EXCHANGE ACT

The Commodity Exchange Act, approved on June 15, 1936, amended the provisions of the Grain Futures Act in the light of the Department's 13 years' experience, and extended the provisions of the statute to embrace cotton, butter, eggs, potatoes, mill feeds, and rice in addition to grains and flaxseed already covered. The short title of the Grain Futures Act, as amended, is the Commodity Exchange Act. Under the amended act the Commission created by the Grain Futures Act (now known as the Commodity Exchange Commission), after notice and opportuntiy for hearing, is directed to establish limitations upon individual traders' speculative commitments in the commodities covered by the act for the purpose of diminishing, eliminating, or preventing the burden of excessive speculation. The act expressly exempts futures transactions for hedging purposes from trading limitations.

Futures commission merchants soliciting or accepting orders for the purchase or sale of commodity futures to be executed on contract markets are required to register annually with the Secretary of Agriculture and to furnish the Secretary such information pertaining to their business as the Secretary may require. Floor brokers engaged in the execution of commodity futures transactions on contract markets likewise are required to register annually with the Secretary of Agriculture and also to furnish such information pertaining to their business as may be required.

For the greater protection of commodity futures customers, margins deposited with futures commission merchants as well as accrued equities are required by the act to be dealt with as belonging to the customer for whom deposited and to be separately accounted for, the law prohibiting their use to extend the credit or to margin the trades of any person other than the customer for whom deposited. Transactions in indemnities, commonly known as "puts" and "calls", are prohibited as well as wash sales, cross trades, accommodation trades, and all fictitious transactions. The bucketing of orders, or becoming the buyer with respect to selling orders, or vice versa, without the prior consent of the customer, is made unlawful, as is cheating or defrauding customers by contract-market members or their agents in connection with the handling of customers' orders. The operation of any bucket shop or the solicitation of commodity futures orders for execution other than by or through a member of a contract market is made a misdemeanor punishable by fine and imprisonment. All contract markets are required to provide for at least 1 day's notice of delivery of any commodity under a commodity futures contract, the Secretary being authorized to require longer notice (not in excess of 10 business days) if found necessary to prevent or diminish unfair practices in trading.

In order to prevent market congestion endangering price stability, the Secretary is authorized, after notice and hearing, to require contract markets to provide for a period of not less than 3 nor more than 10 business days, after trading in the current future of any commodity has ceased, during which delivery may be made on commodity futures contracts. All futures contracts are required to provide for the delivery of commodities conforming to official United States standards. The Secretary of Agriculture is also authorized to require, through appropriate rule and regulation, commodity futures traders to file reports concerning their commodity futures transactions whenever their trades or open commitments equal or exceed amounts fixed by the Secretary.

The amended act affords additional protection to cooperative associations of producers by requiring their admission to membership and contract-market privileges by order of the Commission, the rights of such cooperatives on an exchange being expressly preserved pending the appeal to the courts of any order of the Commission. The authority of the Secretary to deny trading privileges to a person who "is violating" the act, or "is attempting" to manipulate the market price of any grain, had been held by the United States Circuit Court of Appeals for the Seventh Circuit in the case of *Cutten* v. *Wallace* (80 Fed. (2nd) 140), not to apply to completed acts. This decision was affirmed by the Supreme Court on May 18, 1936. The amended statute, therefore, extends the authority of the Secretary to completed as well as current acts in violation of the provisions of the act. Registrations of futures commission merchants and floor brokers are subject to suspension or revocation by the Secretary of Agriculture for cause, and the Commodity Exchange Commission is authorized, in lieu of revoking the designation of a contract market upon a showing that such market is failing or has failed to comply with the provisions of the act or regulations, to issue a cease and desist order against such market or any officer or agent, thereof, failure to comply therewith constituting a misdemeanor subject to fine and imprisonment, or both.

COMMERCIAL VALUE OF FUTURES TRADING

A "futures contract" is an agreement on the part of the seller to deliver and of the buyer to receive, and to pay a certain price for a certain kind and quantity of a commodity at some specified future time under conditions prescribed by an exchange or understood in the trade. Its principal elements, so far as its form is concerned, are: (1) A standard unit of trading, (2) a multigrade contract permitting any one or a combination of a number of grades to be delivered in fulfillment of the contract, (3) price based upon one or more contract grades, (4) commodity deliverable from approved warehouses, (5) commodity graded and weighed by licensed inspectors, (6) commodity deliverable during a specified month, and (7) seller's option as to the grade and the day of the month for delivery.

Not every agricultural commodity is suitable for futures trading. There are six special qualifications which determine the fitness of a commodity to be the basis for futures trading. A commodity must be homogeneous, more or less similar throughout; it must be susceptible of grading; it must be sufficiently durable to last throughout the life of a future (ordinarily about 1 year); trading must be in sufficiently large volume to support the cost of facilities required; the market must not be controlled by a few large operators; and the market must be sufficiently wide to be utilized by more than regional interests. The three major agricultural commodities traded in are wheat, cotton, and corn which together account for approximately 95 percent of all futures trading in the United States.

Futures trading on properly conducted exchanges is commercially useful in several ways. The three principal functions are: (1) Providing a continuous market, (2) aiding in price determination, and (3) making hedging possible. By continuously evaluating known and expected price-making factors in terms of quotations for near and distant deliveries it develops what may be termed the general price level of the commodity. And it makes hedging (protection against price hazards) practicable. All trading in commodity futures consists either in assuming price risks by speculation or shifting price risks by hedging.

A futures market in action resembles an auction. Exchange members gather in pits or rings on the trading floor to negotiate, by competitive outcry of bids and offers, agreements to buy and sell a specified commodity. These agreements are contracts of the peculiar type called "futures."

Fulfillment of contracts is accomplished by tender and delivery of the quantity and quality of the commodity specified or by an offsetting transaction in which there is a substitution of principals and adjustment of price differences, usually through the medium of a clearing association. Members of the exchange who are also members of the clearing association are referred to as "clearing members." In the settlement of contracts by substitution of principals and adjustment of price differences, all agreements to sell and all agreements to buy are, in effect, pooled, the clearing association assuming the dual position of seller to all buyers and buyer to all sellers, with the result that clearing members who have bought and sold like quantities of the commodity for the same delivery hold with a single principal (the clearing association) offsetting contracts that can be immediately satisfied by paying to or receiving from the association the difference in value due to the difference in price. This facility in settlement extends to other member and nonmember traders through the medium of the clearing members. Such settlements far exceed in number those accomplished by transfer of ownership of the actual commodity.

As a futures contract is an agreement to buy and to sell, not a contract of purchase and sale, no part of the price is paid at the time the agreement is entered into. Margins are required by the clearing association when necessary to protect the integrity of contracts accepted for clearance and as a rule members trading as agents require margins from their customers, but such protective deposits amount to but a minor fraction of the actual value of the contracts. Trading on margin greatly increases the extent of the commitment that can be entered into with the funds at a trader's command.

VOLUME OF TRADING IN GRAIN FUTURES

Trading in grain futures on all contract markets in the United States during the fiscal year totaled 16,577,003,000 bushels, an increase of 51 percent over the 11,006,911,000-bushel total for the previous fiscal year. This total approximates the 10-year average 1927–36, of 16,970,000,000 bushels, and is 23 percent above the 5-year 1932–36 average, which was 13,501,000,000 bushels. Table 1 shows the volume of trading for each year since 1926–27 by grains while table 2 shows the volume of trading in each grain by markets during the fiscal year 1937.

TABLE 1.—*Annual volume of trading in wheat, corn, oats, rye, barley, and flaxseed futures for all contract markets combined, by fiscal years, July 1, 1927–June 30, 1937*

[In millions of bushels, i. e., 000,000 omitted]

Year	Wheat	Corn	Oats	Rye	Barley	Flaxseed	Total
1926–27	12, 584	5, 278	1, 407	606	30	59	19, 964
1927–28	11, 201	7, 818	1, 269	513	44	59	20, 904
1928–29	12, 195	5, 831	692	443	82	48	19, 291
1929–30	19, 607	3, 668	946	644	97	38	25, 000
1930–31	10, 063	5, 505	842	498	81	45	17, 034
1931–32	10, 148	2, 639	382	342	31	24	13, 566
1932–33	10, 890	2, 425	571	256	79	26	14, 247
1923–34	10, 093	3, 314	1, 457	495	164	18	15, 541
1934–35	8, 097	3, 725	837	425	54	9	13, 147
1935–36	8, 644	1, 403	655	258	30	17	11, 007
10-year (1927–36) average	11, 352	4, 161	906	448	69	34	16, 970
1936–37	11, 659	2, 952	1, 506	411	41	8	16, 577

TABLE 2.—*Total volume of trading in wheat, corn, oats, rye, barley, flaxseed, and all grain futures combined on the contract markets, fiscal year ended June 30, 1937*

[In thousands of bushels, i. e., 000 omitted]

Market	Wheat	Corn	Oats	Rye	Barley	Flaxseed	All grains	
							Quantity	Percentage
Chicago Board of Trade	10, 152, 099	2, 827, 639	1, 311, 989	337, 819	1, 841		14, 631, 387	88. 3
Chicago Open Board	175, 832	31, 367	7, 499	422			215, 120	1. 3
Kansas City	855, 481	80, 635	4, 756				940, 872	5. 7
Minneapolis	442, 231		174, 689	69, 909	39, 128	7, 337	733, 294	4. 4
Duluth	11, 347			39		804	12, 190	. 1
Milwaukee	16, 407	12, 028	7, 246	2, 539	4		38, 224	. 2
St. Louis	2, 198	57	312				2, 567	(1)
Seattle	1, 923						1, 923	(1)
Portland	679						679	(1)
Hutchinson [2]	395						395	(1)
San Francisco					120		120	(1)
Los Angeles					232		232	(1)
New York								(1)
Total	11, 658, 592	2, 951, 726	1, 506, 491	410, 728	41, 325	8, 141	16, 577, 003	100. 0
Total trading done on Chicago Board of Trade	*Percent* 87. 08	*Percent* 95. 80	*Percent* 87. 09	*Percent* 82. 25	*Percent* 4. 45		*Percent* 88. 26	

[1] Less than 0.1 percent
[2] Trading in grain futures was officially terminated at Hutchinson, Kans., Sept. 12, 1936.

Each grain showed a substantial increase, but flaxseed declined drastically. Trading in wheat futures, which comprised 70 percent of all trading in grain futures, advanced from 8,644,146,000 bushels in 1936 to 11,658,592,000 bushels in 1937, an increase of 35 percent. The volume of trading in corn futures increased from 1,403,398,000 bushels in 1936 to 2,951,726,000 in 1937, or 110 percent. The volume of trading in oats futures increased from 654,671,000 bushels in 1936 to 1,506,491,000 bushels in 1937, or 130 percent. The volume of trading in rye futures increased from 257,862,000 bushels in 1936 to 410,728,000 bushels in 1937, an increase of 59 percent. The volume of trading in barley futures increased from 29,692,000 bushels in 1936 to 41,325,000 bushels in 1937, or 39 percent. Trading in flaxseed futures, on the other hand, declined from 17,142,000 bushels in 1936 to 8,141,000 bushels in 1937, a reduction of 53 percent.

Of the total volume of trading in all grain and flaxseed futures, 81 percent, or 14,631,387,000 bushels, was transacted on the Chicago Board of Trade during the year. The Kansas City Board of Trade was second with 940,872,000 bushels, or 5.7 percent; the Minneapolis Chamber of Commerce third with 733,294,000 bushels, or 4.4 percent; the Chicago Open Board of Trade fourth with 215,120,000 bushels, or 1.3 percent; while the remaining nine contract markets authorized to trade in grain futures each accounted for less than 0.25 percent of the total.

It would be a mistake to assume that because there has been an increase of 50 percent in the volume of trading in grain futures during 1937 over 1936 the economic welfare of the country has been substantially improved by this large volume of trading. The situation is not comparable to a 50-percent increase in the wheat or corn crop or even in the price of a commodity which adds directly to the wealth of the community. First should be mentioned the fact that the quantity of futures contracts which may be set up by purchase and sale is unlimited. The two primary functions of trading in commodity futures are (1) The market-making function, and (2) the hedging function. When the maximum of efficiency in these two functions has been reached any further volume of trading is economically useless. It is difficult, however, to measure for any given period the precise amount of trading required to provide maximum efficiency.

The average daily volume of trading on the Chicago Board of Trade in wheat futures during 1937 was 33,840,000 bushels compared with 24,001,000 for 1936 and 22,734,000 for 1935. The daily average for corn was 9,425,000 for 1937, 4,337,000 for 1936, and 11,639,000 for 1935. The daily average for oats was 4,373,000 for 1937, 1,829,000 for 1936, and 2,516,000 for 1935. The daily average for rye was 1,126,000 for 1937, 632,000 for 1936, and 1,269,000 for 1935. The daily average for barley was 6,000 for 1937, 3,000 for 1936, and 35,000 for 1935.

The largest amount of trading in a single day in wheat futures during 1937 was 87,026,000 bushels. The largest single day's trading in wheat in the history of the Chicago Board of Trade, insofar as records are available, occurred on July 20, 1933, when 163,099,000 bushels were sold.

The average daily volume of trading and the largest and smallest amount of trading in any single day during 1937 for each grain are shown in table 3.

TABLE 3.—*Average daily volume of trading in grain futures on the Chicago Board of Trade, from July 1, 1936, to June 30, 1937, with dates when largest and smallest day's trading occurred*

[In thousands of bushels, i. e., 000 omitted]

Grain	Average daily volume of trading	Largest amount of trading in single day		Smallest amount of trading in single day	
		Quantity	Date	Quantity	Date
	Bushels	*Bushels*		*Bushels*	
Wheat	33,840	87,026	June 29, 1937	7,455	Oct. 24, 1936
Corn	9,425	22,877	Aug. 3, 1936	1,520	Do.
Oats	4,373	17,759	July 31, 1936	356	Oct. 31, 1936
Rye	1,126	3,616	July 7, 1936	60	Do.
Barley	6	141	Nov. 24, 1936	0	(1)
All grains	48,771	113,695	June 29, 1937	10,098	Oct. 24, 1936

[1] Frequently.

OPEN COMMITMENTS

Another measure of activity on futures markets is the amount of open commitments. Open commitments consist of futures contracts which have not been fulfilled by delivery or offset by other contracts of sale or purchase in the same commodity and delivery month. They are, in other words, outstanding transactions, and might be compared, for purposes of illustration, with the unfilled orders of a manufacturer.

Total open commitments represent the aggregate of the contracts which customers have assumed (either long or short) as of any given date, which contracts must later be settled either by offset or delivery. These data relate to one side only, since contracts open on the long side equal contracts open on the short side.

The general tendency is for the aggregate of open commitments in wheat futures to start the year (July) with a low figure, increase gradually until a peak is reached in December or January, and to decline from that time on. Normally open commitments moderately exceed the visible supply, this relationship arising from the practice of hedging in the futures markets of the commercial stocks of grain.

Total open commitments of all customers in all wheat futures combined on the Chicago Board of Trade were 56,838,000 bushels on July 1, 1936, declined to 55,712,000 bushels, the low figure of the year, on July 3, then advanced almost uninterruptedly to 114,120,000 bushels, the high figure of the year, on March 16, 1937, and declined to 84,831,000 bushels on June 30. Table 4 shows the total open commitments of all customers in all wheat futures combined on the Chicago Board of Trade for semimonthly dates from July 1, 1936, to June 30, 1937.

TABLE 4.—*Open commitments in the various wheat futures on the Chicago Board of Trade for semimonthly dates from July 1, 1936, to June 30, 1937* [1]

Year and date	Future				
	July	September	December	May	All futures
1936					
July 1	10,671,000	31,547,000	14,620,000		56,838,000
July 15	4,629,000	40,755,000	24,617,000	74,000,000	70,075,000
July 31		42,977,000	39,796,000	6,701,000	89,474,000
Aug. 15		24,038,000	46,918,000	21,316,000	92,302,000
Aug. 31		11,128,000	48,820,000	31,143,000	91,091,000
Sept. 15	71,000	5,627,000	50,241,000	33,431,000	89,370,000
Sept. 30	1,973,000		51,270,000	41,650,000	94,893,000
Oct. 15	4,183,000		48,726,000	45,140,000	98,049,000
Oct. 31	5,179,000		47,025,000	49,359,000	101,563,000
Nov. 14	7,777,000		41,502,000	52,017,000	101,296,000
Nov. 30	16,010,000		23,381,000	60,849,000	100,240,000
Dec. 15	19,702,000	120,000	9,511,000	64,425,000	93,758,000
Dec. 31	25,879,000	1,506,000		74,378,000	101,763,000
1937					
Jan. 15	29,180,000	7,653,000		71,830,000	108,663,000
Jan. 30	29,137,000	11,229,000		65,469,000	105,835,000
Feb. 15	27,157,000	14,579,000		64,398,000	106,134,000
Feb. 27	28,636,000	16,794,000		62,939,000	108,369,000
Mar. 15	32,004,000	20,783,000		59,728,000	112,515,000
Mar. 31	34,057,000	24,651,000		51,924,000	110,632,000
Apr. 15	35,938,000	28,191,000		45,834,000	109,963,000
Apr. 30	38,869,000	32,195,000		25,436,000	96,500,000
May 15	43,262,000	34,089,000		9,964,000	87,315,000
May 29	48,399,000	37,189,000	3,431,000		89,019,000
June 15	31,657,000	45,426,000	11,845,000		88,928,000
June 30	11,491,000	55,191,000	18,149,000		84,831,000

[1] High—Mar. 16, 1937, 114,120,000 bushels. Low—July 3, 1936, 55,712,000 bushels.

Total open commitments in all corn futures on the Chicago Board of Trade opened the year on July 1, 1936, with 23,438,000 bushels, declined to 21,623,000 bushels on July 8, then advanced to a high of 56,195,000 on November 5, and gradually declined, closing the year on June 30, 1937, at 34,036,000 bushels. Table 5 indicates the total open commitments in the various corn futures on the Chicago Board of Trade for semimonthly dates from July 1, 1936 to June 30, 1937.

TABLE 5.—*Open commitments in the various corn futures on the Chicago Board of Trade for semimonthly dates from July 1, 1936, to June 30, 1937* [1]

Year and month	Future					
	July	September	December	May	Other	All futures
1936						
July 1	4,655,000	9,993,000	8,790,000			23,438,000
July 15	2,322,000	8,930,000	13,149,000			24,401,000
July 31		10,552,000	15,530,000	2,997,000		29,079,000
Aug. 15		9,774,000	21,093,000	13,157,000		44,024,000
Aug. 31		6,508,000	23,537,000	17,342,000		47,387,000
Sept. 15	1,000	5,048,000	26,501,000	19,214,000		50,764,000
Sept. 30	872,000		28,481,000	22,687,000		52,040,000
Oct. 15	3,022,000		29,789,000	20,817,000		53,628,000
Oct. 31	5,018,000		28,791,000	20,739,000		54,548,000
Nov. 14	9,094,000		24,474,000	20,520,000		54,088,000
Nov. 30	11,463,000		19,548,000	22,265,000		53,276,000
Dec. 15	13,880,000		9,138,000	27,938,000		50,956,000
Dec. 31	12,485,000	904,000		28,966,000		42,355,000
1937						
Jan. 15	11,657,000	3,861,000		23,722,000	10,000	39,250,000
Jan. 30	11,679,000	5,636,000		20,919,000		38,234,000
Feb. 15	12,606,000	6,681,000		19,107,000		38,394,000
Feb. 27	11,964,000	6,556,000		17,478,000		35,998,000
Mar. 15	11,775,000	7,261,000		15,869,000		34,905,000
Mar. 31	11,661,000	8,548,000		12,241,000		32,450,000
Apr. 15	13,598,000	12,324,000		7,579,000		33,501,000
Apr. 30	13,029,000	14,137,000		5,373,000		32,539,000
May 15	13,276,000	14,727,000	1,723,000	3,571,000		33,297,000
May 29	13,055,000	13,791,000	4,143,000			30,989,000
June 15	11,850,000	15,632,000	6,583,000			34,065,000
June 30	7,625,000	16,259,000	10,152,000			34,036,000

[1] High—Nov. 5, 1936, 56,195,000 bushels. Low—July 8, 1936, 21,623,000 bushels.

SPECIAL ACCOUNTS

In addition to the total volume of trading and the total open commitments, the Commodity Exchange Adminstration receives daily a record of all special accounts carried by futures commission merchants. These so-called special accounts show each day the market position of each of the leading traders. Thus, for wheat futures, Chicago Board of Trade, the position of each trader is reported each day, if such position equals or exceeds 200,000 bushels in any one future. Similarly, reports are received for other grains and other markets.

These special accounts of leading traders have been regularly received for the various grains for a number of years and are presently to be regularly received for cotton and other commodities coming under the Commodity Exchange Act. In the actual enforcement of the Grain Futures Act they have been extremely valuable. As an initial step in the interpretation of these records, a broad classification into speculative, hedging, and spreading accounts is made. The hedging accounts are in turn divided into those reflecting changes in the cash position of (1) elevators and (2) processors. Similarly, the speculative accounts are further classified and analyzed by subgroups and by individual interests.

Prepared in this manner, changes in the net trades and positions of leading speculators and hedgers can be currently followed in connection with the market trend in prices and changes in prices between futures and between markets. Through the various exchanges, it is necessary at times to place a limitation on unusually large positions. In extreme cases it has been found necessary to require partial liquidation. During the past year regulatory work in this field has related mainly to outstanding contracts in maturing futures. Where supplies are small, as they have been during the past season for corn, large positions in the futures market can easily cause erratic price changes distinctly harmful to the producer and the distributor of grain. At such times close supervision of leading accounts is essential to assure an orderly market.

It will be observed from table 6 that in point of number there are comparatively few large accounts. During the fiscal year 1937 these special accounts never exceeded 100 at any one time in contrast to the many thousands of small accounts. It should not be inferred, however, that number of accounts is an adequate measure of market importance. While few in number, special accounts are market giants capable at times of giving pronounced direction to prices. During the fiscal year approximately 70 percent of these accounts were on the long side of the market with 30 percent on the short side.

TABLE 6.—*Number of speculative accounts which had positions, either long or short, equal to or in excess of 200,000 bushels, for wheat futures, Chicago Board of Trade, by months, July 1936–June 1937*

Year and month	Accounts for indicated, size of position							
	Less than 500,000 bushels		500,000 to 995,000 bushels		1,000,000 to 1,995,000 bushels		2,000,000 bushels and over	
	Long	Short	Long	Short	Long	Short	Long	Short
1936	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
July	67	12	10	2	1	2		
August	51	15	16	4	1			
September	42	15	13	1	1			
October	43	20	8		2	1		
November	48	21	8	1	4			
December	54	18	10	5	5			
1937								
January	51	21	6	5	4	1	1	
February	41	13	5	4	4	1	2	
March	48	22	6	3	6		1	
April	43	32	8	6	3	2		2
May	31	24	8	9	2	2		2
June	46	31	7	4	2	6		2

In tables 7 and 8 the aggregate open commitments of special accounts are shown both in actual amounts and as percentages of the total open commitments of all customers. Table 7 presents the positions for wheat and table 8 for corn,

Chicago Board of Trade. As percentages of total open commitments on the long side of the market, the special accounts having open commitments of 200,000 bushels or more averaged for wheat between 25 and 33 percent of the total open contracts; for corn, between 25 and 50 percent. On the short side, they averaged between 58 and 75 percent for wheat and between 21 and 58 percent for corn. Thus in market positions they assume much greater importance when contrasted with the many small accounts.

TABLE 7.—*Monthly average open commitments in all wheat futures combined on the Chicago Board of Trade for all customers, with the quantity and percentage held by special and small accounts July 1, 1936–June 30, 1937*

Year and month	Average total open commitments all customers (short side only)	Special accounts having open commitments of 200,000 bushels or more				Small accounts having open commitments of less than 200,000 bushels			
		Long	Long	Short	Short	Long	Long	Short	Short
	1,000 bushels	*1,000 bushels*	*Percent*	*1,000 bushels*	*Percent*	*1,000 bushels*	*Percent*	*1,000 bushels*	*Percent*
1936									
July	72,485	19,721	27.21	45,581	62.88	52,764	72.79	26,904	37.12
August	91,798	23,425	25.52	68,335	74.44	68,373	74.48	23,463	25.56
September	91,259	24,311	26.64	67,957	74,47	66,948	73.36	23,302	25.53
October	99,064	29,951	30.23	73,760	74.46	69,113	69.77	25,304	25.54
November	100,617	31,943	31.75	71,823	71.38	68,674	68.25	28,794	28.62
December	97,171	31,837	32.76	69,285	71.30	65,334	67.24	27,886	28.70
1937									
January	106,328	31,460	29.59	77,402	72.80	74,868	70.41	28,926	27.20
February	106,000	34,211	32.27	71,628	67.57	71,789	67.73	34,372	32.43
March	110,748	36,013	32.52	69,828	63.05	74,735	67.48	40,920	36.95
April	106,031	32,284	30.45	61,884	58.36	73,747	69.55	44,147	41.64
May	90,600	25,240	27.86	55,403	61.15	65,360	72.14	35,197	38.85
June	88,114	27,720	31.46	52,512	59.60	60,394	68.54	35,602	40.40

TABLE 8.—*Monthly average open commitments in all corn futures combined on the Chicago Board of Trade for all customers, with the quantity and percentage held by special and small accounts during the period July 1, 1936–June 30, 1937*

Year and month	Average total open commitments all customers (short side only)	Special accounts having open commitments of 200,000 bushels or more				Small accounts having open commitments of less than 200,000 bushels			
		Long	Long	Short	Short	Long	Long	Short	Short
	1,000 bushels	*1,000 bushels*	*Percent*	*1,000 bushels*	*Percent*	*1,000 bushels*	*Percent*	*1,000 bushels*	*Percent*
1936									
July	24,335	6,201	25.48	5,767	23.70	18,134	74.52	18,568	76.30
August	41,339	16,997	41.12	15,945	38.57	24,342	58.88	25,394	61.43
September	50,621	23,736	46.89	20,562	40.62	26,885	53.11	30,059	59.38
October	53,640	26,447	49.30	22,052	41.11	27,193	50.70	31,588	58.89
November	53,738	23,289	43.34	20,845	38.79	30,449	56.66	32,893	61.21
December	49,177	15,411	31.34	20,578	41.84	33,766	68.66	28,599	58.16
1937									
January	39,319	14,505	36.89	22,748	57.85	24,814	63.11	16,571	42.15
February	37,586	11,697	31.12	18,449	49.08	25,889	68.88	19,137	50.92
March	34,312	11,148	32.49	14,630	42.64	23,164	67.51	19,682	57.36
April	33,098	10,466	31.62	11,024	33.31	22,632	68.38	22,074	66.69
May	32,877	10,002	30.42	8,082	24.58	22,875	69.58	24,795	75.42
June	33,907	12,297	36.27	7,419	21.88	21,610	63.73	26,488	78.12

As a means of further analysis, these special accounts have been divided in table 9 (wheat) and table 10 (corn) into two broad groups, namely, speculative and hedging, showing aggregate and net market positions for each group by months.

TABLE 9.—*Daily average open commitments in all wheat futures on the Chicago Board of Trade of all speculative special accounts and all hedging special accounts, July 1936–June 1937*

Year and month	Speculative			Hedging		
	Aggregate long	Aggregate short	Net position [1]	Aggregate long	Aggregate short	Net position [1]
1936						
July	13,609,000	5,961,000	+7,648,000	6,067,000	39,630,000	−33,563,000
August	17,775,000	7,150,000	+10,625,000	5,572,000	61,074,000	−55,502,000
September	16,050,000	6,172,000	+9,878,000	8,273,000	61,781,000	−53,508,000
October	17,967,000	9,140,000	+8,827,000	11,984,000	64,293,000	−52,309,000
November	18,216,000	10,427,000	+7,789,000	13,522,000	61,439,000	−47,917,000
December	23,654,000	11,991,000	+11,663,000	8,143,000	57,490,000	−49,347,000
1937						
January	29,564,000	17,214,000	+12,350,000	1,897,000	60,214,000	−58,317,000
February	31,652,000	18,606,000	+13,046,000	2,503,000	53,104,000	−50,601,000
March	33,066,000	22,775,000	+10,291,000	2,947,000	47,065,000	−44,118,000
April	27,189,000	27,126,000	+63,000	5,096,000	34,897,000	−29,801,000
May	21,071,000	31,480,000	−10,409,000	3,903,000	23,955,000	−20,052,000
June	13,978,000	32,576,000	−18,598,000	13,695,000	19,913,000	−6,218,000

[1] A plus (+) in this column indicates a net long position for the group; a minus (−) a net short position.

TABLE 10.—*Daily average open commitments in all corn futures on the Chicago Board of Trade of all speculative special accounts and all hedging special accounts, by months, July 1936–June 1937*

Year and month	Speculative			Hedging		
	Aggregate long	Aggregate short	Net position [1]	Aggregate long	Aggregate short	Net position [1]
1936						
July	2,667,000	2,216,000	+451,000	3,490,000	3,535,000	−45,000
August	7,273,000	6,656,000	+617,000	9,634,000	9,144,000	+490,000
September	10,858,000	9,773,000	+1,085,000	12,756,000	10,746,000	+2,010,000
October	12,129,000	11,400,000	+729,000	14,295,000	10,677,000	+3,618,000
November	8,099,000	8,036,000	+63,000	15,184,000	12,810,000	+2,374,000
December	5,126,000	5,294,000	−168,000	10,267,000	15,283,000	−5,016,000
1937						
January	9,595,000	10,139,000	−544,000	4,910,000	12,609,000	−7,699,000
February	7,279,000	6,890,000	+389,000	4,418,000	11,559,000	−7,141,000
March	5,960,000	4,382,000	+1,578,000	5,192,000	10,248,000	−5,056,000
April	7,131,000	4,743,000	+2,388,000	3,340,000	6,354,000	−3,014,000
May	7,740,000	3,966,000	+3,774,000	2,262,000	4,089,000	−1,827,000
June	10,882,000	3,699,000	+7,183,000	1,426,000	3,720,000	−2,294,000

[1] A plus (+) in this column indicates a net long position for the group; a minus (−) a net short position.

It will be observed that with respect to both groups their interest in the market was divided throughout the year—that is, they were in part long and in part short. This division, however, was not a balanced one. The hedgers show in fact a much larger short than long position during the crop-moving months, reflecting the fact that the hedging of stocks of wheat and corn considerably overbalances the hedging of forward sales. It will be observed further with respect to the hedgers that their net short position varied seasonally during the year in response to changes in commercial stocks of wheat.

For this particular year the large speculative wheat accounts show a net long position of varying amounts from July 1936 through March 1937, reaching a maximum average long position in February of 13,000,000 bushels. During March and April this long position was liquidated to be replaced during May and June by a short position of over 18,000,000 bushels. For the large speculative corn accounts, net market positions ranged during this crop year from a long position in September of 1,084,000 to a short position in January of 544,000 to return again to a long position in June of 7,183,000 bushels.

With respect to speculative positions, it should be observed that they do not vary as do the hedging accounts with variations in the stocks of actual grain. There is in fact no seasonal pattern followed by these leading traders either as individuals or as a group. They are at times as a group heavily long, at other times heavily short; at times the long positions of some offset the short positions of others to leave the net position of the group relatively small. In general, the combined market position of these leading speculators, particularly when large or when changing rapidly, correlates directly with levels and changes in the wheat-price structure. It is mainly for this reason that they merit careful and continuous observation by the Administration.

ROUND LOTS AND JOB LOTS

Contracts to buy or sell commodity futures must be in amounts (or multiples thereof) established by the exchange as trading units if the price is to be registered as an official quotation. For example, the trading unit in any grain on the Chicago Board of Trade is 5,000 bushels. These trading units are known as round lots to distinguish them from fractional units which are called job lots. Purchase prices on job lots are usually at one-eighth to one-quarter cent above and sales prices at one-eighth to one-quarter cent below the prevailing market price as determined by transactions in round lots.

The volume of trading in job lots and its percentage of the total volume is especially important inasmuch as such trading ordinarily represents the operations of small speculators.

As is shown in table 11, on the Chicago Board of Trade during the fiscal year, job lots constituted 9.58 percent of the trading in wheat futures, 13.02 percent of trading in corn futures, 8.70 percent in oats futures, and 6.66 percent in rye futures.

TABLE 11.—*Volume of trading in grain futures and the volume and percentage in job lots on the Chicago Board of Trade during the fiscal year 1937*

[In thousands of bushels; i. e., 000 omitted]

Year and month	Wheat			Corn		
	Total volume of trading	Job lots		Total volume of trading	Job lots	
		Volume	Percentage		Volume	Percentage
1936						
July–September	2,569,942	246,457	9.59	975,815	130,759	13.40
October–December	1,884,859	185,847	9.86	580,451	71,628	12.34
1937						
January–March	2,417,086	240,742	9.96	458,350	57,660	12.58
April–June	3,280,212	299,811	9.14	813,023	108,213	13.31
Total	10,152,099	972,857	9.58	2,827,639	368,260	13.02

Year and month	Oats			Rye		
	Total volume of trading	Job lots		Total volume of trading	Job lots	
		Volume	Percentage		Volume	Percentage
1936						
July–September	439,107	41,276	9.40	77,258	4,427	5.73
October–December	235,452	20,249	8.60	62,689	3,818	6.09
1937						
January–March	285,992	25,825	9.03	86,117	6,450	7.49
April–June	351,438	26,850	7.64	111,755	7,823	7.00
Total	1,311,989	114,200	8.70	337,819	22,518	6.66

DELIVERIES

Of the total volume of trading on the Chicago Board of Trade in all futures of all grains which expired during the fiscal year only 0.26 percent was settled by delivery. Table 12 shows the extent to which all futures contracts expiring during the fiscal year were settled by delivery of grain. It will be noted that the proportion of deliveries is small: For wheat not exceeding 0.3 percent with an average for all grain futures of 0.26 percent. Deliveries of corn were approximately in the same proportion as for wheat; oats and rye deliveries ran up to about 3 percent; while deliveries of barley ranged as high as 27 percent of the total volume of trading in one future.

TABLE 12.—*Volume of trading (sales) during the life of each principal grain future on the Chicago Board of Trade expiring during the fiscal year 1937, and futures contracts settled by delivery* [1]

[In thousands of bushels, i. e., 000 omitted]

Grain, month, and year	Volume of trading during life of future (sales)	Futures contracts settled by delivery		Grain, month, and year	Volume of trading during life of future (sales)	Futures contracts settled by delivery	
		Volume	Percentage of total sales			Volume	Percentage of total sales
Wheat:				Rye:			
July 1936	1,340,034	538	0.04	July 1936	20,189	686	3.40
September 1936	1,608,971	342	.02	September 1936	42,201	356	.84
December 1936	1,815,828	1,481	.08	December 1936	58,775	511	.87
May 1937	3,286,039	9,986	.30	May 1937	102,778	1,510	1.47
Total	8,050,872	12,347	.15	Total	223,943	3,063	1.37
Corn:				Barley:			
July 1936	178,791	307	.17	July 1936	360	85	23.61
September 1936	298,177	937	.31	September 1936	336	22	6.55
December 1936	907,334	928	.10	December 1936	813	5	.62
May 1937	754,082	170	.02	May 1937	587	160	27.26
Total	2,138,384	2,342	.11	Total	2,096	272	12.98
Oats:				Grand total	11,560,235	30,462	.26
July 1936	60,051	1,937	3.23				
September 1936	212,888	2,397	1.13				
December 1936	311,622	1,684	.54				
May 1937	560,379	6,420	1.15				
Total	1,144,940	12,438	1.09				

[1] These totals are not comparable with those of the volume of trading during the fiscal year inasmuch as trading in these futures begins approximately 10 months before the delivery month and consequently cover a larger part of the fiscal year 1936 than of 1937.

Contrary to popular belief, the very small proportion of futures contracts filled by delivery does not indicate manipulation, squeezes, or congestion. The very opposite is in fact likely to be the case. When deliveries can be made easily and economically they are likely to be in the smallest proportion to total volume of futures contracts. There are sound and practical reasons for this. In the first place, cash contracts are used in the marketing of the actual physical commodity, while futures contracts are used as a means of speculation and hedging. Persons entering the futures markets ordinarily do not want to take or make delivery. It is easier and more economical to close out the transaction by making another offsetting one. Moreover, as futures contracts provide for the delivery of one of several grades of a commodity (at a premium or discount in some instances) at seller's option, the purchaser cannot be certain he will receive the grade of the commodity which he could utilize. Another reason why deliveries are seldom made in fulfillment of futures contracts is that oridinarily the actual physical commodity will bring a premium in the cash market over its value in the futures market.

PRICE MOVEMENTS OF FUTURES

WHEAT

The general trend of prices of wheat futures during the year was distinctly upward The advance had already started late in May 1936, and continued until early August. Accompanying the advance in price was a marked increase in speculative activity. Trading in Chicago wheat futures for July 1936 rose to over 1 billion bushels. On August 19, 1936, September wheat sold at $1.16⅜ as compared with 83⅛ cents, the low on May 28, an increase of approximately 40 percent within 90 days.

There was a net gain of 9¼ cents in price of the September future during June and an advance of 17 cents in July. Futures prices in Liverpool, Winnipeg, and Buenos Aires also showed substantial advances. The primary factor accounting for these advances was the unfavorable crop reports which continued to come from the spring wheat belt of the United States and Canadian Northwest where drought had seriously injured the crop. In addition, there also was a marked reduction in the size of the European wheat crop and world wheat supplies were reduced to the smallest since the 1926–27 season.

Following a temporary recession in prices in late August due to weakness in foreign markets with a slower export demand, the prices of wheat futures again resumed an upward course in early September. The rise in prices continued until the middle of October when again there was a moderate recession followed by quiet prices until late in November. From August to November the trading in futures was less active. The set-back was apparently caused by the weakness in the Liverpool market due to the improvement in the Argentine crop conditions with pressure of offerings of Argentine wheat for January shipment. In November prices of futures again rose rapidly.

By December 28 the price of May wheat, accompanied by a sharp increase in speculative activity during December, had advanced to a high of $1.37¾, or an increase of 26¼ cents from the low on November 2. This advance was principally the result of the political unrest in Europe with a tight supply situation and apparently a desire on the part of several countries—England, Italy, and Germany—to build up stocks of wheat in fear of war. In addition a tight situation had developed in the December future at Chicago which had a range of 23⅛ cents during the delivery month.

In January wheat futures prices again dropped. The trading, which had become less active, was influenced by the weakness in the Liverpool market, due to the pressure of Argentine shipments. In February prices again rose, the price of May wheat going from a low to $1.25¾ on January 28 to a high of $1.38½ by February 13. The main bullish factor was the strength in the Liverpool market because of renewed buying by importing countries, Germany and Italy being the outstanding buyers. The dust storms in the southwestern part of the United States also had some influence on prices.

After a slight recession in the last 2 weeks of February prices of futures advanced until the May future reached a peak price of $1.45⅛ and July wheat $1.30¾ by April 5. The March advance, during which month trading for the third time during the year reached the billion-bushel mark, was principally influnced by the heavy buying of South American and Canadian wheat by Germany and Italy and the rapid advances in prices of other commodities.

During April, another billion-bushel trading month, the trend in prices was sharply downward. By the 28th May wheat was again at a low of $1.25 and July wheat at $1.14⅝. The decline was started in North American markets. The weakness that followed in the Liverpool market together with a less urgent demand for wheat by Europe resulted in prices dropping sharply. Additional factors influencing prices were the improved prospects for winter wheat and the more favorable moisture conditions for spring wheat. The favorable progress made by winter wheat also was reflected in the low prices paid for new-crop futures during the first 2 weeks of May. During the remainder of May and early June the wheat futures market was primarily a weather affair, traders being influenced principally by reports of crop conditions in the United States and Canada.

The rapid advance in prices of wheat futures between June 14 and June 29 was occasioned by the rust scare and the drought in western Canada. It was associated with a marked increase in speculative activity which made June another billion-bushel month. September wheat during the last 2 weeks of June, advanced from a low of $1.05 on June 14 to a high of $1.24⅝ by the 29th.

CORN

The general trend of corn futures prices was also upward. The very sharp advance in price in July and August 1936, accompanied an increased speculative activity which had already started in June 1936. The rise carried the price of September futures from a low of 66⅛ cents on July 1 to a high of $1.19½ on August 19. This was an advance of 53⅜ cents, or about 80 percent, in less than 2 months. The August 19 price was the highest paid for September corn since May 1, 1928, when it was $1.16. The advance in price of December corn, the new-crop future during the same period, was 40½ cents or from 62⅛ cents to $1.02⅝. The rapid advance in price was apparently due to drought conditions. In addition a tight situation developed in the September future because of the relatively small quantity of cash corn in deliverable position. This gave rise to the feeling that some difficulty would be encountered in the closing out of September contracts.

In August the price of the December future declined slightly and remained more or less stable, with a small speculative activity, until the end of October. The decline was brought about primarily by substantial rains, which materially improved crop conditions.

From November 1936 until the middle of January 1937 a second major advance took place in the prices of corn futures, accompanied by renewed speculative activity. May corn rose from a low of 89¾ cents on November 2, 1936, to a high of $1.13⅛ on January 14, 1937. The December future advanced from 94⅜ cents on November 2 to $1.11⅝, on December 28, the last trading day of the future. The main bullish influence was the tight situation in the expiring future. Stocks of corn in deliverable position were exceedingly small in proportion to the open contracts in December corn during the delivery month.

In the last 2 weeks of January there was a moderate recession in prices. In late February another major advance in corn futures prices carried May corn from $1.04¾ on February 25 to $1.33⅛ on April 5. These advances were due to the strong cash demand, light country offerings, and the prospect of a tight situation in the May future.

Liquidation in the May future, further arrivals of Argentine corn, and favorable weather for planting corn brought about a moderate decline in prices of corn futures between April 5 and 16. Thereafter prices again moved irregularly upward until the May future reached a high of $1.40 on May 26, the last day of trading in that future. This situation was associated with some congestion in May deliveries.

With favorable crop conditions, larger country offerings of cash corn, and increased importation of Argentine corn, prices of corn futures declined during the first half of June 1937. July corn broke from $1.27 on May 28, to $1.10¼ on June 14. The trading in corn futures during the entire month of June was relatively large, over 300,000,000 bushels.

OATS

Price movements of Chicago oats futures resembled those of corn futures. The extent of the fluctuations, however, was smaller. From July 1 to August 19 there was a sharp advance of 14¾ cents in September oats, from 30¾ to 45½ cents. This was followed by a moderate decline, ended on November 2, with the December future at 40¾ cents. A broad rise then took place and by January 14, 1937, the price of May oats had risen 14 cents. During the remainder of the crop year the price trend was moderately downward. The May future declined to 45 cents by May 12, but by the last day of trading in that future had advanced to 56¼ cents.

RYE

The movement of rye futures prices at Chicago during the 1936–37 crop year was similar to that of wheat futures. From July 1 to August 19, 1936, September rye advanced from 64⅛ to 86⅞ cents, an increase of 22¾ cents. From the latter date until November 2 a series of minor movements occurred without any great change in price. As in the other grains, a rapid upward movement occurred in November and December 1936, which carried the price of May rye from 80⅝ cents on November 2 to $1.19⅜ on December 28. This was an increase of 38¾ cents or about 48 percent in less than 2 months. A January decline carried the price to $1.06½. After some recovery it broke to $1.02½ by February 25. An advancing market then carried the price to $1.23½ on May 26, the last trading day.

During the latter part of May and the first part of June the July rye future declined, reaching 77¾ cents on June 14. It then recovered, going to 94¾ cents by the end of the month.

ENFORCEMENT OF COMMODITY EXCHANGE ACT

In order to enforce properly the Commodity Exchange Act, it is necessary for the Commodity Exchange Administration to designate contract markets, register futures commission merchants and floor brokers, examine the books and records of futures commission merchants, and to supervise trading operations so that manipulation, the circulation of false crop and market information, and other illegal practices may be prevented as far as possible. In the following sections these activities are briefly described.

DESIGNATION OF CONTRACT MARKETS

Sixteen commodity exchanges, which are listed in the following tabulation, are now designated contract markets. Twelve of these exchanges were so designated under the Grain Futures Act; the remaining four, namely, the Chicago Mercantile Exchange, New Orleans Cotton Exchange, New York Cotton Exchange, and the New York Mercantile Exchange, have been designated during the past year under the provisions of the Commodity Exchange Act.

Contract market	*Futures trading conducted under the act in—*
Chicago Board of Trade	Wheat, corn, oats, rye, barley, and cotton.
Chicago Mercantile Exchange	Butter, eggs, and potatoes.
Chicago Open Board of Trade	Wheat, corn, oats, and rye.
Duluth Board of Trade	Wheat, rye, and flaxseed.
Kansas City Board of Trade	Wheat, corn, oats, and millfeeds.
Los Angeles Grain Exchange	Barley.
Milwaukee Grain and Stock Exchange	Wheat, corn, oats, and rye.
Minneapolis Chamber of Commerce	Wheat, corn, oats, rye, barley, and flaxseed.
New Orleans Cotton Exchange	Cotton.
New York Cotton Exchange	Do.
New York Mercantile Exchange	Butter and eggs.
New York Produce Exchange	No trading under the act since April 1932.
Portland Grain Exchange	Wheat.
St. Louis Merchants Exchange	Wheat, corn, oats, and millfeeds.
San Francisco Chamber of Commerce, Grain Trade Association of.	Barley.
Seattle Grain Exchange	Wheat.

Futures transactions in the commodities covered[1] are restricted by the Commodity Exchange Act to boards of trade (commodity exchanges) duly designated as contract markets by the Secretary of Agriculture. This designation is made upon a showing by the applicant exchange that it complies, and will continue to comply, with all conditions precedent to designation set forth in the act.

REGISTRATION OF FUTURES COMMISSION MERCHANTS AND FLOOR BROKERS

Registration by the Secretary of Agriculture is required of all futures commission merchants engaged in soliciting or accepting commodity futures orders to be executed on or subject to the rules of a contract market, and of all commodity futures floor brokers engaged in executing orders for others on contract markets.

As of August 20, 1937, 901 futures commission merchants and 665 floor brokers had been registered under the act. Principal and branch offices maintained by registered futures commission merchants number 2,263, and are located in 46 States, the District of Columbia, Hawaii, and 14 foreign countries. All registrants are required to furnish the Secretary of Agriculture such information as may be required relative to their business and the commodity futures transactions of their customers, as well as to keep books and records in such form and manner as the Secretary may require. Registrations must be renewed annually, and are subject to suspension or revocation for cause.

[1] Wheat, cotton, corn, oats, rye, barley, flaxseed, butter, eggs, potatoes, millfeeds, grain sorghums, and rice.

The following tabulation shows the location, by States, of the principal offices of futures commission merchants registered under the act from August 28, 1936, to August 20, 1937:

	Number		Number
Alabama	13	Montana	5
Arkansas	1	Nebraska	13
California	25	New York	215
Colorado	5	North Dakota	1
District of Columbia	2	Ohio	14
Connecticut	1	Oklahoma	5
Delaware	1	Oregon	5
Georgia	13	Pennsylvania	13
Idaho	2	Rhode Island	1
Illinois	238	South Carolina	4
Indiana	6	South Dakota	2
Iowa	5	Tennessee	8
Kansas	5	Texas	35
Kentucky	4	Utah	3
Louisiana	35	Virginia	1
Maryland	13	Washington	6
Massachusetts	10	Wisconsin	13
Michigan	1	Foreign: England	1
Minnesota	87		
Mississippi	5	Total	901
Missouri	84		

MANIPULATION

Throughout the fiscal year there were comparatively small stocks of deliverable grain in Chicago. This resulted in a continuous threat of tight situations in current maturing futures. In an endeavor to prevent any extreme price movements the Commodity Exchange Administration, acting through its supervisor in Chicago, took vigorous steps upon three occasions to correct the situation.

CONGESTION IN DECEMBER WHEAT AND DECEMBER CORN

Early in the month of November it became apparent that there was an excessively large open interest in December corn. As stocks of corn in Chicago were very low, the local supervisor of the Administration called the attention of the business conduct committee of the Chicago Board of Trade to the situation. Information was given the committee concerning the amount of December corn held by speculators as a group, both long and short, the maximum and minimum lines, the total amount both long and short held by elevator hedgers and processor hedgers, and amounts held by round-lot and job-lot spreaders. The supervisor also pointed out that one firm alone had a long position in December corn of nearly 8,000,000 bushels.

In view of the seriousness of this situation and the likelihood of serious congestion, the Administration on December 8 issued a call to all clearing members having an open position in wheat of 100,000 bushels or more and in corn of 25,000 bushels or more to report their open contracts. When these reports were received, they confirmed the view that one firm had an excessively large position in both wheat and corn. The business conduct committee thereupon issued an order to that clearing firm to refrain from adding to its open contracts and to liquidate by the middle of December approximately 40 percent of its open contracts in December wheat and December corn. This order was later amended by changing the percentage to be liquidated from 40 to 30.

This situation was closely followed both by the representatives of the Administration and the business conduct committee. As a consequence the December futures were closed out in a fairly satisfactory manner without the erratic price changes which undoubtedly would have developed in December wheat and December corn had not this vigorous action been taken.

CORN AND RYE CONGESTION DURING MAY

Early in April 1937, representatives of the Administration working in collaboration with the business conduct committee, made a preliminary survey of the open

interest in May corn and May rye. During the next 3 weeks open commitments in these two futures were closely followed. As these investigations had focused attention upon these two futures, traders having large long positions liquidated their holdings rapidly.

As the May rye situation became increasingly difficult, a special call for reports of all accounts in May wheat, corn, oats, and rye was issued on May 15 by the Administration. These reports showed that the short interest in May futures was widely scattered throughout the country. However, one speculator who already had a large long position in May rye, continued to buy that future. After discussion of the subject between the representatives of the Administration and the business conduct committee, the committee ordered this member to buy no more May rye and to liquidate his long position. This was done.

As a result of the vigilance of the local representatives of the Administration and the cooperation of the business conduct committee the month closed without violent price movements.

DECLINE IN POTATO PRICES

During the 3 weeks beginning March 15, 1937, the Administration received numerous complaints, principally from potato growers in Idaho, relating to the sharp decline in potato prices. Inasmuch as trading in potato futures is maintained only upon the Chicago Mercantile Exchange and the decline which had taken place since the first of the month had been rather drastic, the Chicago office was instructed to make a complete investigation of every phase of the situation to determine the possible existence of manipulation.

Prices of potato futures had dropped from a high of $3.68 per hundredweight on March 1 to a low of $2.25 on March 23, a decline of $1.43, or 39 percent. The weighted average of spot potatoes had declined from a high of $3.55½ on March 10 to a low of $2.52 on March 31, a maximum decline of $1.03½, or 29 percent. An analysis of the purchases and sales of potato futures which had been executed between March 8 and 17 revealed that 23.4 percent were sales for short account, 19.2 percent were purchases for long account, with the remaining 57.4 percent representing sales in liquidation of long account and purchases to cover short account. Of the sales for short account approximately one-half were for the account of potato dealers.

Careful investigation disclosed no evidence of any effort on the part of any group to force the prices of potato futures downward. The small volume of trading in potato futures on the Chicago Mercantile Exchange, especially when compared with the much broader volume of business in spot potatoes throughout the country, indicated that future trading of itself had little if any effect upon the level of prices during that period. Rather, it appeared that some traders in futures anticipated the March decline in the light of the obvious fact that the prices of old potatoes were high, with new potatoes already appearing in quantity on the market.

ELIMINATION OF IMPROPER PRACTICES

Elimination of fraudulent and improper practices in futures trading is provided for through two channels. The Commodity Exchange Act prescribes that each board of trade shall prohibit manipulation and the dissemination of false and misleading information to influence prices as one of the conditions of its designation as a contract market. Should any board of trade fail to comply with this provision of law the remedy would lie in the revocation of its designation as a contract market. Experience under the Grain Futures Act revealed, however, that the application of this remedy for minor manipulative attempts was too severe. Accordingly, the Commodity Exchange Act includes several other provisions directed to individual traders themselves. Such practices as cheating, issuing false reports, deceiving customers, or bucketing orders on the part of any person were made criminal offenses.

Unfortunately, the commodity exchanges are not yet free of such improper practices, but constant supervision is being maintained to apprehend and prosecute those who engage in them. The Commodity Exchange Act has brought within the jurisdiction of this Administration 4 additional commodity exchanges with over 500 members. Many of these are relatively unacquainted with the requirements of the act. In an endeavor to impress upon the members of contract markets the seriousness of engaging in prohibited practices, numerous statements have been issued to the press outlining the type of such practices and stressing the criminal provisions of the law. Constant supervision over the trading on each contract market has also been maintained.

Each field office of the Commodity Exchange Administration has devoted considerable time and effort during the year to the prevention and elimination of fraudulent practices and fictitious transactions. An especial attempt has been made to detect any transaction of the character of a wash sale, cross trade, or of bucketing—i. e., the practice of a commission house taking the opposite side of its customers' trade instead of executing it in the open market—or cheating, defrauding, or deceiving customers. The public has been urged to submit to the Washington office or any of the field offices specific cases of apparent violation of the act with the assurance that every such complaint will be treated as confidential, thoroughly investigated, and remedial action taken if required. As the fiscal year came to a close several detailed investigations of apparent cases of bucketing were being conducted, and if the evidence warrants prosecution will be instituted.

EXAMINATION OF BOOKS AND RECORDS

The Commodity Exchange Act specifically requires all futures commission merchants to maintain books and records pertaining to all futures transactions, which books and records shall be open to inspection by any representative of the Departments of Agriculture or Justice. This provision is essential to the proper enforcement of the act. The registration of any person failing to comply with it may be suspended or revoked.

It is contemplated that the accounts and records of every futures commission merchant will be examined in the near future and periodically thereafter. In practically every instance of suspected violation of the act it will be desirable to scrutinize the books and records of the persons or firms involved.

Frequent recourse to this authority in fact has already been made. In conducting an investigation of the sharp decline in potato prices in April 1937 on the Chicago Mercantile Exchange, for example, the accounts and records of 18 futures commission merchants were examined in detail and the transactions of approximately 230 persons analyzed in an effort to determine whether or not manipulation had taken place.

HANDLING OF CUSTOMERS' FUNDS

The law requires futures commission merchants to treat all money, securities, and property received from customers to margin guarantee, or secure customers' trades as belonging to the customer. It prohibits the use of such property to margin the trades of or to extend credit to any other person.

Shortly after the passage of the act a statement was issued which pointed out that the statute makes the relationship of a futures commission merchant to his customer one of agency from the beginning to the end of the entire transaction. As agent the commission merchant can have no other, further, or different interest in the results, profits, or accruals from the contracts of his customers than the collection of commissions, interest, taxes, storage, and other charges lawfully accruing in connection with such contracts. The statement further emphasized the fact that full compliance with the act requires segregation not only of customers' moneys received to margin or guarantee trades in commodity futures but also of moneys and equities accruing to customers as a result of payments received from the clearing-house association of a contract market covering settlements to the market each day.

During recent months a major portion of the time of the accountants in the field has been devoted to the creation of a sound, workable system for the segregation of customers' funds. To this end surveys have been made of the books and records of numerous futures commission merchants operating on the various contract markets.

ISSUANCE OF FALSE CROP OR MARKET INFORMATION

As the success or failure of traders in commodity futures is largely dependent upon their ability to secure, interpret, and evaluate market information concerning production, distribution, and trading activities, the leading exchanges have become centers for such information. They have developed a very detailed, elaborate system of collecting and publishing information having a bearing on futures prices.

Prior to the passage of the Grain Futures Act in 1922 one of the most commonly used devices to influence prices was the issuance of false or misleading information. The act provided that boards of trade must prevent the dissemination by the board or any member thereof, of false or misleading or knowingly

inaccurate reports concerning crop or market information or conditions that affect or tend to affect the price of any grain by the dealers or operators upon such board. This provision, amended to include the other commodities, is included in the Commodity Exchange Act. The contract markets cooperate actively in the suppression of misleading or false information but, nevertheless constant vigilance must be maintained to detect and suppress such information.

Each field office of the Administration closely scrutinizes market information and advice issued by futures commission merchants. Many commission houses issue monthly or weekly bulletins and a number issue daily market letters presenting facts and opinion upon a wide range of current market topics.

Upon numerous occasions during the year the representatives of the Administration called to the attention of the exchange officials questionable reports or news items important enough to influence prices. It was also necessary in several instances to notify futures commission merchants and news agencies that reports which had been published were false or misleading. In one instance, for example, a report was issued predicting that the wheat crop of one State would be about the largest in history whereas other estimates, including that of the Department of Agriculture, were approximately half as large. This report came just before the issuance of the Federal Government estimate and most of the private estimates, and was given Nation-wide circulation. In another instance a firm included in one of its market letters an inaccurate report concerning the damage caused by black rust to the wheat crop. When upon investigation it developed that the issuing firm had not been in a position to benefit from an increase in prices no further action was taken than to caution the firm against the issuance of unconfirmed rumors. Another type of misleading information is illustrated by the issuance by a ticker service of an unsubstantiated report concerning the purchase of grain for export. A careful investigation was made to determine the accuracy of the information as well as the existence of an ulterior motive for the statement. When it became apparent that the report was purely a mistake and not issued to influence prices, further action was discontinued.

REPORTING REQUIREMENTS UNDER COMMODITY EXCHANGE ACT

One of the primary purposes of the Grain Futures Act was to enable the Department of Agriculture to collect, analyze, and disseminate comprehensive information concerning trading in grain futures. Prior to 1922 when that act became law authentic information had not been available. Few business transactions were more carefully guarded than those relating to trading in grain futures. Now detailed information relating to grain futures transactions are available and made public.

In many respects the situation today relating to cotton, butter, eggs, potatoes, and millfeeds is comparable to that of grain futures as it was in 1922. No authentic information is publicly available concerning the volume of futures trading in those commodities, the amount of open contracts, the volume of deliveries, the types and relative importance of the operations of hedgers, large speculators and other traders, and similar information essential to an understanding of the operations on organized markets. Yet we do know that the broad effect of futures trading upon spot prices is as great in these commodities as in grain.

Insofar as cotton is concerned, practically the entire American crop is bought and sold at prices based upon the price of some future on the New York Cotton Exchange or New Orleans Cotton Exchange. The Administration contemplates the compilation and periodic publication of the volume of trading in cotton futures and of open contracts as well as daily prices on the three contract markets on which cotton futures trading takes place. There are also various technical aspects of futures trading in this commodity, such as the effect of multigrade and southern deliveries, desirability of establishing maximum speculative limits and the effect of transferring delivery notices, which require special investigation.

The situation in butter, eggs, potatoes, and millfeeds is similar. While it is known that the volume of trading in these commodity futures is very much smaller than in cotton, there is a very definite relationship between the futures transactions and the orderly marketing of the spot commodities. The Administration expects to determine the character and extent of this relationship and then describe it to the public.

Table 13 summarizes the reporting requirements issued by the Administration.

TABLE 13.—*Summary of reporting requirements contained in articles I, II, III, IV, V, VI, and VII issued by the Secretary of Agriculture under the provisions of the Commodity Exchange Act*

Form no.	Commodity	By whom made	Frequency	Requirements
150	All commodities.	Futures commission merchants.	Monthly	Total purchases and total sales of each commodity during the calendar month; open contracts in each commodity as of the close of last business day.
160	do	do	Upon call	Total amount of money and credits held for and accruing to customers; total amount of money segregated for benefit of commodity customers.
200	Grains	Clearing members	Daily	Total open accounts in futures at previous close; trades today; total open accounts at close today; net position at close today; deliveries made and received; delivery notices passed today.
300	Cotton			
400	Butter			
500	Eggs			
600	Potatoes			
700	Millfeeds			
01		Futures commission merchants and contract market members.[1]	do	Net long or net short position (by futures) of each special account. (Individual accounts in any 1 future on one or more contract markets equal to or exceeding, for grains, 200,000 bushels; for cotton, 5,000 bales; butter, eggs, and potatoes, 25 carlots; and millfeeds, 500 tons.)
02		do.[1]	With new reports.	Identification of special accounts; name of person for whom account is carried, address; names of other persons having interest in account; whether holder of account is engaged in cash commodity business; whether hedging, spreading (straddling), speculative, or commission house.
03		Every person [2]	Daily [3]	Show by markets and futures total open contracts; whether hedging, spreading, or speculative; total daily transactions; and deliveries made and received.
04	(4)	Cash grain or spot cotton merchants or processors.[2] [4]	Weekly [4]	Net cash (spot) positions; make-up of net cash positions; open contracts in all futures on all exchanges; and call cotton position, and futures upon which based.[4]

[1] Who carry accounts with open interests equaling or exceeding, for grains, 200,000 bushels; for cotton, 5,000 bales; for butter, eggs, and potatoes, 25 carlots; for millfeeds, 500 tons.
[2] Whose open contracts in any 1 future equal or exceed the amounts specified in footnote 1.
[3] No report required if open interest remains unchanged.
[4] Report required for grain and cotton only.

LITIGATION

The constitutionality of the Commodity Exchange Act was challenged in three cases brought in Federal district court to enjoin its enforcement. Two of the cases originated in Chicago and one in Kansas City. All three cases were dismissed upon hearing in the United States district courts. Petitions for certiorari direct to the United States Supreme Court were denied and on appeal to the United States circuit courts of appeals, decisions were rendered upholding the constitutionality of the law.

The first case, known as *Moore* v. *Chicago Mercantile Exchange* was filed in the United States District Court at Chicago on August 15, 1936; the second case, known as *Board of Trade of Kansas City* v. *Milligan*, was filed in the United States District Court at Kansas City, August 28, 1936; and the third case, known as *Bennett* v. *Board of Trade of the City of Chicago*, was filed in the United States District Court at Chicago, September 5, 1936.

The *Moore case* and the *Bennett case* were consolidated for hearing before the United States Circuit Court of Appeals for the Seventh Circuit, and the opinion of that court was rendered June 10, 1937. (90 Fed. (2d) 735.) The two principal points of attack in these two cases were (1) that the law as laid down by the United States Supreme Court in the *Olsen case* (*Chicago Board of Trade* v. *Olsen* (262 U. S. 1)), upholding the constitutionality of the original Grain Futures Act

of 1922, had been overruled in later cases involving the National Industrial Recovery Act (*Schechter* v. *United States* (295 U. S. 495) and *Carter* v. *Carter Coal Co.* (298 U. S. 238)); and (2) that Congress in amending and extending the Grain Futures Act to apply to futures transactions in butter, eggs, and potatoes had no basis for its finding that these commodities were subject to price manipulations in interstate commerce and that regulation was necessary.

In disposing of the first point, the court said:

> One must indeed close his eye to factual realities who cannot see the line of demarcation between the holdings in the *Carter* and *Schechter cases* and the holdings in the *Jones & Laughlin case*, and other cases decided April 12.
>
> Nor can we, by the widest stretch of our reasoning faculties, accept the contention that the *Schechter* and the *Carter cases* dealt with the same fact situations that confronted the Court in the *Wallace* and *Olsen cases*.
>
> In the *Wallace* and *Olsen cases* the Court was dealing with the power of Congress to regulate an intrastate business which indirectly burdened interstate commerce. In such cases the Court held that where congressional action, regulatory in character, was based upon appropriate findings that the intrastate commerce which was the subject of regulation was closely and intimately related to interstate commerce and was a burden thereon, there was no violation of the Constitution. * * * We find the *Olsen case* of all those cited the most nearly similar in point of fact to the one before us. Indeed it might be said that the material facts of the instant case are not distinguishable from the *Olsen case*.

In disposing of the point that Congress had no basis for its finding that legislation was necessary with respect to butter, eggs, and potatoes, the Court said it could not review such a finding without reason or without evidence of facts of which it might take judicial notice:

> We cannot say that the evidence in the case before us was not sufficient to support the finding. Nor do we expect Congress to have the same sort of hearings to establish a fact as would be followed if a court were investigating a fact issue. * * * There is nothing, however, of which we can take judicial notice, and there is nothing offered in the evidence which in the least suggests that the finding which Congress made in this act is contrary to the facts.

In the Kansas City case, attack was centered more particularly on those provisions in the Commodity Exchange Act which deal with the prohibition of cheating and fraud, wash trades, and trading in privileges; also upon the authority vested in the Commodity Exchange Commission to fix limitations upon speculative trading. The provisions safeguarding the treatment and handling of customers' funds were also attacked.

The United States Circuit Court of Appeals for the Eighth Circuit rendered its opinion June 24, 1937 (90 Fed. (2d) 855). It also held that the opinion in the *Olsen case* had not been overruled, and said:

> In *Chicago Board of Trade* v. *Olsen*, supra, the general features, purpose and effect of the act are reviewed and considered. The present act, which is amendatory of the Grain Futures Act, is of the same general character as that directed to the same general purpose; to wit, to remove burdens on interstate commerce caused by manipulation and market control. A discussion of this question would now seem to be an act of supererogation, and plaintiffs' contention in this regard cannot be sustained.

With reference to the attack on the power of the Commission to fix speculative-trading limits as an unlawful delegation of legislative power, the court said the attack would seem to be premature. The court said:

> The order of the Commission is to be made only "after due notice and opportunity for hearing." With such a safeguard against arbitrary action, it will not be presumed in advance of the making of an order that the Commission will violate any rights. There is a presumption that public officers will not only do their duty, but that they will perform such duties faithfully. If and when orders shall have been made, it will be time enough to consider them with a view of determining whether they violate any constitutional rights.

In disposing of the point that section 4d (2) of the act dealing with customers' margins and funds was unconstitutional, the court said:

> It is urged that this regulation is not within the power of Congress under the Constitution. The regulation, however, appears to have a direct relation to interstate commerce. It may well stimulate a confidence in customers of the commission merchant that their money will not be lost through improper use. By preventing improper uses, speculation and the abnormal consequences resulting therefrom will be diminished, if not prevented. Freedom of contract, in its proper sense, is not abrogated by this provision.

Following the rendition of the decisions by the circuit courts of appeals, petitions for certiorari were filed and are now pending seeking the review by the Supreme Court of the decisions in all three cases.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - Price 5 cents

REPORT OF THE CHIEF OF THE BUREAU OF DAIRY INDUSTRY, 1937

United States Department of Agriculture,
Bureau of Dairy Industry,
Washington, D. C., September 15, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I submit herewith a report of the work of the Bureau of Dairy Industry for the fiscal year ended June 30, 1937.

Sincerely yours,

O. E. Reed, *Chief.*

CONTENTS

INTRODUCTION

The Bureau has continued its general program of research and extension work, with some additional studies and changes in emphasis to meet changing conditions. The results of the year's work along the various lines of research are summarized in the following pages, and attention is called to the progress made in the application of the information in the industry.

Dairymen throughout the country are taking more interest than ever before in the growing and feeding of grasses and other roughage crops. This is undoubtedly due to a number of factors. The Bureau's feeding experiments in recent years have shown the economy of using larger quantities of roughage crops in the dairy ration, particularly roughage of good quality. These results indicate that roughage crops not only furnish the essential nutrients for milk production at less cost than the grain crops, but that these less expensive nutrients will account for 60 to 70 percent of a cow's maximum production on full-grain rations. The soil-conservation program has been an important factor in focusing interest on these results, the extension workers have stressed the advantages of producing good-quality roughage, and the drought has also been a factor. Emphasis in the Bureau's research with roughages during the year was largely on methods of harvesting, curing, and storing to preserve valuable nutritive properties.

Probably the Bureau's most outstanding accomplishment during the year, in putting the results of research information to work in the field, was the

inauguration of the program for recording the identity, family history, and production records of all animals in dairy herd-improvement associations. This program is the outgrowth of 30 years of cow-testing association work and 19 years of research by the Bureau in the breeding of dairy cattle. The Bureau's breeding experiments had demonstrated that the surest and quickest way to develop strains of uniformly high producing cattle is by the use of a good proved sire in each successive generation.

To apply the proved-sire system of breeding on a large scale among the average herds of the country it seemed advisable to start a concerted effort to find large numbers of good proved sires—that is, sires that have demonstrated through their progeny that they transmit uniformly high levels of production. The dairy herd-improvement associations, with their 490,000 cows and 17,000 bulls, afford a promising source of production records for proving large numbers of sires.

Accordingly, at the beginning of the year the Bureau arranged, with the cooperation of the State dairy extension services, to file a record of the identity and production performance of every animal in these association herds. Production records on every daughter of each association sire, and on the dams of the daughters, are now being filed with the Bureau as rapidly as they are available and tabulated automatically to prove the sires of the daughters. In the first year of operation, some 1,500 association bulls have been listed as "proved" by the records of at least five daughter-dam comparisons.

With complete and accurate information on all cows and bulls in these associations available for study, it should be possible to make a genetic analysis of many individual herds in the near future. Such studies will enable members of dairy herd-improvement associations to center their breeding program around animals and strains of known merit.

No country in the world excels the United States in the general quality of its dairy products, yet there is still room for improvement in the quality of the milk and cream produced on many farms in this country. Dairy leaders all recognize that poor quality not only fails to attract new consumers but that it tends to discourage regular consumers. Maintenance of a high standard of quality in all dairy products is perhaps the most important factor in maintaining or increasing consumption. Research is supplying the essential information, and the Federal and State extension services are making gradual progress in bringing about the adoption of practices that assure good quality. This has been particularly true in the last few years, with respect to the production of cream for butter making. Nearly all States are doing some quality-improvement work; many of them now have cream-grading laws and creameries are paying a premium for good quality. An intensive campaign in Colorado during the year eliminated 90 percent of the lowest grade cream. Tennessee affords an outstanding example of what can be accomplished by concerted and cooperative effort on the part of farmers, creamery operators, and extension workers. Butter produced in that State now compares favorably with that from many of the older dairy States.

Regulations (B. D. I. Order No. 1—revised) covering all phases of the Bureau's activities in the enforcement of the Process or Renovated Butter Act were revised in December 1936 and have greatly strengthened the inspectional authority. Sanitary conditions surrounding the production and marketing of renovated butter have been improved materially. The five factories now handling this product made 2,737,181 pounds during the year as compared with 2,252,920 pounds the preceding year. This was an increase last year of about 22 percent, and marks the fourth consecutive year of increase.

On January 1, 1937, a new Division of Nutrition and Physiology was established in the Bureau to combine the work formerly done by the Division of Breeding, Feeding, and Management with respect to investigations of the physiology of milk secretion and reproduction and the work formerly done by the Division of Dairy Research Laboratories on various phases of dairy-cattle nutrition.

In the course of the year this Bureau and the Bureau of Animal Industry began a cooperative breeding investigation in which bulls of the Red Danish breed will be used on Red Polled and Milking Shorthorn cows in an effort to determine the effect of heterosis on the milk-producing level and on the efficiency of meat production. Studies will also be made on the mode of inheritance of other characters.

DIVISION OF DAIRY HERD-IMPROVEMENT INVESTIGATIONS

J. C. McDowell, *in charge*

STATUS OF THE ASSOCIATION HERDS

On January 1, 1937, there were 992 dairy herd-improvement associations in the United States, testing 20,772 herds consisting of 496,562 cows. This is an increase of 116, or 13.2 percent, in number of associations and 92,150, or 22.8 percent, in number of cows on test, as compared to the number on January 1, 1936.

The first dairy herd-improvement association completed its first year of testing cows for economical production of milk and butterfat in 1906 with an average butterfat production of 215 pounds per cow. Thirty years later in 1936 the average butterfat production of the cows on test was 319 pounds per cow. The gain in 30 years was 104 pounds of butterfat per cow, or 48 percent.

Table 1 shows the average milk and butterfat production per cow of all the cows on test each year from 1929 to 1936, inclusive.

Table 1.—*Average milk and butterfat production for all cows on test in dairy herd-improvement associations, 1929–36*

Year	Milk	Butterfat	Year	Milk	Butterfat
	Pounds	*Pounds*		*Pounds*	*Pounds*
1929	7,498	298	1933	7,849	313
1930	7,642	303	1934	8,015	322
1931	7,812	306	1935	7,980	322
1932	7,358	310	1936	7,912	319

The slight decline in production in 1936 as compared with 1935 is doubtless due to the increase of more than 50,000 in the number of cows on test. Such a large gain in 1 year in number of cows on test can hardly be accomplished without dipping down into lower strata of production.

The average production of all cows kept for milk in the United States in 1936, according to preliminary estimates by the Bureau of Agricultural Economics, was about 4,300 pounds of milk and 170 pounds of butterfat. Therefore, the cows in the average herd-improvement association are producing almost twice as much per cow as the average milk cow in this country.

The average production per cow in these associations is now so high that it is difficult to make much gain in a year's time through selection and feeding. Progress in the future evidently lies in the more general use of high-class proved sires and the sons of such sires.

PROVED-SIRE WORK

During the year 1,168 sires were proved in dairy herd-improvement association herds. This is the largest number proved in any 12-month period.

The first printed list of sires proved in dairy herd-improvement associations was issued during the year. This list includes the records of all sires proved from November 1, 1935, to April 1, 1937. All sires were proved under the uniform rules of the dairy herd-improvement association proved-sire program. These rules provide that 305-day lactation records shall be used. All records are adjusted to a 6-year-old mature basis and reduced to a twice-a-day milking basis. When a dam or daughter has more than one lactation the average record is used to represent her producing capacity.

The 1,533 sires in the list had been mated to dams whose average production was 9,712 pounds of milk (testing 3.8 percent of fat) and 373 pounds of butterfat. The daughters of these dams had an average production of 9,553 pounds of milk (testing 3.9 percent of fat) and 373 pounds of butterfat.

It would appear that no progress was made by these sires in improving the dairy cattle in association herds. This would be correct for the group as a whole. However, 458 of the sires may be considered as having definitely improved production because the average production of the daughters of each of these sires excelled the average of their dams by 25 pounds of butterfat

or more, the margin considered necessary to be significant. On the average, the 458 sires were able to raise or hold production when mated to dams having an average production level up to 405 pounds of butterfat.

Five hundred and six sires may be considered as having definitely lowered production, because their daughters failed by 25 pounds or more of butterfat to equal their dams. The remaining 589 sires had daughters whose production approximately equaled that of their dams.

While the data indicate that only 458 of the sires were capable of raising production, such is not the case. Practically all the 1,553 sires would have been capable of raising the production in the average herd in the United States. Those sires that decreased production to the greatest extent were usually those that had been mated to high-producing dams. These sires probably would have held or raised production had they been mated to dams in their own production class or lower. One of the principal objectives of the proved-sire program is to make sufficient information available, on great numbers of dairy sires, so that it will be possible to place all proved sires in herds in which they will be good enough to raise production, or at least hold it at the same level.

IDENTIFICATION AND PERMANENT RECORD PROJECT

Herd improvement through breeding has been an important part of the dairy herd-improvement association program. A widespread breeding program is not possible, however, unless both the sire and dam of each animal in the association herds are known and their identity is a matter of record. Of the 496,000 cows in association herds more than 400,000 are grade animals and have not been satisfactorily identified for the purpose of proving sires. A project was inaugurated during the past year to eartag, and record the identification of, all grade animals so their production records may be used in conducting a breeding program in the same way as the records of animals registered with the various breed associations.

With such information available, individuals (both male and female) that possess and transmit an inheritance for high-producing capacity may be singled out and efforts may be made to perpetuate and disseminate their influence throughout the dairy-cow population. In this way the animals in association herds may serve as a Nation-wide breeding herd to supply improved breeding stock to the national dairy herd of 25,000,000 cows.

Forty-five of the forty-six States with active dairy herd-improvement associations have joined in the program. During the year the States purchased and distributed among their associations 429,000 special dairy herd-improvement association eartags. Testers were trained in conducting the project in the local associations. Identification records of approximately 85,000 animals had been reported by the testers at the close of the year, and the records were coming in at the rate of about 1,000 a day.

This Division has set up an extensive system for filing the identification and production records reported by the testers. The records are so cross-indexed that dam-and-daughter information will accumulate in routine manner on every sire that has a daughter in an association herd. Family lines may be traced in grade herds as well as in registered herds. Sires will be proved and their breeding value indicated by the thousand, where in the past they have been proved only by the hundred.

Specifically, the association member will receive the following major benefits from the identification and permanent record project:

(1) Every animal in an association member's herd will be positively identified and these identification records, together with all production records, will be recorded in the member's herd-record book. With complete records readily available on each animal, the association member will have the information necessary to conduct a progressive breeding program in his herd.

(2) Information will accumulate on every sire as fast as his daughters are tested. As soon as sufficient data accumulate proved-sire records will be tabulated by the Bureau of Dairy Industry and promptly returned to the State, which, in turn, will forward the tabulations to the owners of the sires. With this current information an owner will have an idea of the breeding value of his herd sire at the earliest possible moment.

(3) Every 6 months, a list of all sires proved in dairy herd-improvement associations during the preceding 6-month period, will be made available. This list should be of value to dairymen in locating new herd sires.

(4) As production records accumulate year after year on each tested herd, all data that have been reported for the herd will be summarized and tabulated periodically by the Bureau and returned to the State colleges, where the data may be useful in making a genetic analysis of the herd for the owner. With this complete information the dairyman will be able to evaluate the various family lines within his own herd, and build his future herd from his best families.

COOPERATIVE BULL ASSOCIATIONS

The number of cooperative dairy bull associations in operation on January 1, 1937, was 160. These associations had a total membership of 2,507 dairymen, owning cooperatively 694 dairy bulls. The number of bull associations is 140 less than the number reported a year ago, but this decrease is due to the fact that during the past year, for the first time, definite standards were established as to what constitutes a cooperative dairy bull association.

In previous years many organizations listed as associations were in reality bull clubs, circles, or exchanges. Beginning this year, an organization to be listed as a cooperative dairy bull association must maintain the following standards: (1) The association must have the necessary officers to insure its operation; a constitution and bylaws must be adopted and the members must sign a membership agreement. (2) The association shall own three or more bulls and shall consist of three or more blocks. (3) The association bulls must be owned by the association, and this ownership must be recorded in the herdbooks of the various breed associations; no association bull shall be owned by an individual. (4) To be reported as an active association the organization must hold at least one meeting a year.

A new feature of cooperative bull associations recommended this year to improve the chances of getting good bulls for the association is what is known as the "spare-bull" plan. Under this plan an active association, with a bull assigned to each block as usual, buys a young bull to be circulated among the various herds in the association at definite periods each year. Each member agrees to use the young bull on a few heifers and an occasional cow in order to have a representative sample of his calves for proving his transmitting ability. As soon as the daughters of the bull have completed their production records, the association decides on the merits of the bull, basing their judgment on the dam-and-daughter records in all the association herds rather than in only one herd. This plan distributes the risk in selecting young sires and provides a desirable means of bringing young proved bulls into the association herds when needed for replacement purposes.

DAIRY-FARM RECORDS

Recognizing that information based on records of all phases of dairy farming would be of value to dairy farmers, the Bureaus of Dairy Industry and of Agricultural Economics entered into a cooperative project in March 1936 for analyzing and summarizing such complete farm records as could be obtained through dairy herd-improvement associations.

During the year the work has been organized on a cooperative basis in 13 States, and approximately 1,400 farm records are being kept on dairy herd-improvement association farms. Approximately half of the cooperators are in the East, Middle West, and West, and the other half in the Southern States.

Records of the complete farming operations on dairy farms now accumulating show: (1) To what extent family labor income may be increased by varying the proportions of concentrates and roughages fed as prices of feeds and prices of dairy products rise and fall; (2) to what extent the family labor income may be improved by expanding certain enterprises and curtailing others in order to meet the effective demand for farm products of all kinds; and (3) that with a fixed acreage and with prevailing prices the net income may often be increased by a change in number of cows, by changes in season of freshening, and by changes in cropping system.

The major objective in collecting such figures and information is to aid dairy farmers to adjust and operate their farms more efficiently, to develop good cropping practices, rotations, and livestock programs, and to bring about such balanced relationships between the various phases of the dairy-farm business, based on available labor, as will give dairy farmers the largest continuous income and purchasing power over a period of years.

BREEDING, FEEDING, AND MANAGEMENT INVESTIGATIONS

R. R. GRAVES, *in charge*

THE EXPERIMENTAL BREEDING HERDS AT BELTSVILLE, MD.

BREEDING EXPERIMENTS WITH HOLSTEIN-FRIESIAN CATTLE

King Ormsby of Iodak 576357 was brought into the Holstein herd in March for use as the sixth proved sire on the project to develop strains pure in their inheritance for a high level of production through the continuous use of unrelated proved sires. He is being mated to daughters of Chief Piebe Ormsby Burke, the fifth sire. The latter has 22 outbred and 4 inbred daughters still alive, and he continues to be an active breeder although he is past 13 years of age. Eight daughters of Chief have completed first-calf records which average 14,413 pounds of milk and 553 pounds of butterfat, starting their tests at the average age of 2 years 1 month. On a mature-equivalent basis they average 2,087 pounds more milk and 121 pounds more butterfat than their dams.

Table 2 shows the present status of this project, giving the number of daughters of each sire still in the herd and the average production of those that have been tested for milk and butterfat production. The production figures are final only for the first sire, as daughters completing later records may alter the averages for their sires. In addition to the above outbred daughters there are two inbred daughters of Varsity Derby Matador and four of Chief Piebe Ormsby Burke in the herd.

TABLE 2.—*Average production (mature-equivalent basis) of daughters of the first 5 proved sires used in the Holstein herd*

Sire	Outbred daughters in herd	Daughters with records	Average production		
			Milk	Butterfat	
	Number	*Number*	*Pounds*	*Percent*	*Pounds*
Denton Colantha Sir Rag Apple	0	33	19,059	3.49	663
Varsity Derby Matador	8	31	19,409	3.54	684
Pride of the Bess Burkes	3	9	16,430	3.88	641
Count Piebe Hengerveld Ormsby	5	5	19,631	3.62	710
Chief Piebe Ormsby Burke	22	8	19,861	3.85	762

On the project comparing line breeding with outbreeding there are still five daughters of Sir Gerben Colantha Rube in the herd, and there is further evidence that they fail to produce up to their inherent capacity when they are milked by machine. Eleven of his tested daughters have averaged 19,249 pounds of milk and 662 pounds of butterfat. There are 12 daughters of Pride Ormsby Gerben Colantha Ona which constitute the second line-bred generation. The daughters of this sire have made a splendid showing as producers, as the first six to finish averaged 19,495 pounds of milk and 765 pounds of butterfat on a mature-equivalent basis. Both of these sires have inbred daughters in the herd, and there is also a group of seven inbred daughters by a son of Varsity Derby Matador. Four line-bred heifers are now in the third line-bred generation.

Summing up briefly, the Holstein females number 81, of which 38 are outbred, 21 line-bred, and 22 inbred; and 33 of these, representing all groups and all females that are old enough to have completed production records, have records which average 18,926 pounds of milk and 683 pounds of butterfat. Since the projects were begun, 146 Holstein cows have completed 219 official production records, which average 15,602 pounds of milk and 548 pounds of butterfat at the average age of 3 years 9 months. Only 65 of these records were made by cows over 5 years of age. Seven cows appeared in the 1936 honor list of the Holstein-Friesian Association.

Since the results of the germ-plasm survey were published in the 1936 Yearbook of Agriculture there has been some interest in noting the influence of certain females as shown by the development of certain families descended from foundation cows. In this herd there has been no selection to foster the

development of families, and descendants of all foundation cows have always had equal opportunities to perpetuate and distinguish themselves. Many cases have been cited to illustrate the dominant influence of a certain female by calling attention to the preponderance of her progeny in the herd. Whether or not this result just happened, or was due to a program set up in the early history of such herds, is often difficult to determine. At any rate, the following is what has occurred in the Beltsville herd, where all females had the same chance to build up family dominance and where all were mated to the same sires and encountered the same disease hazards. Of the 41 foundation cows bred to Denton Colantha Sir Rag Apple only 18 had female progeny by him, so 18 possible families were set up. Two of them failed to go beyond the first generation, but as the herd stands today 14 of the 18 are still represented by live females. One line has dwindled to a single individual, 4 others have 2 members still alive, 1 has 3, 3 have 4, 2 have 5, 1 has 9, 1 has 13, and 1 has 25. These last two families account for nearly half the herd today.

According to some authorities, many high-record cows fail as breeders, but it happens here that the foundation cow on which the group of 25 rested was the highest producer of the entire foundation herd. Perhaps leadership in numbers depends on an early start, although this does not necessarily follow. Three foundation cows each had four daughters by Denton Colantha Sir Rag Apple, so they were off to an even start in the first generation. However, at present 1 has 25 and the other 2 have only 5 female descendants each. The cow with 13 female descendants in the herd had only 2 daughters, and the cow with 9 had 3 daughters. Two other foundation cows that had three daughters each are represented now by one, two, and three female descendants each. The fact that a cow produces a goodly number of heifer calves does not necessarily mean that her daughters will do likewise. If this characteristic were transmitted uniformly, the prolific individuals of bygone years would dominate the breed today.

BREEDING EXPERIMENTS WITH JERSEY CATTLE

There are 66 females in the Jersey herd, of which 37 are outbred, 22 linebred, and 7 inbred. Thirty of these have Register of Merit records which average 12,271 pounds of milk and 632 pounds of butterfat on a mature-equivalent basis. During the year 20 cows under 5 years of age completed records averaging 9,786 pounds of milk and 524 pounds of butterfat, starting at the average age of 3 years 5 months.

Three major groups (Raleigh, Owl-Interest, and Sophie-Tormentor) are maintained. Table 3 lists the proved sires used in each group, the number of daughters still in the herd, and the average production of the tested daughters. These averages are based on records made by daughters in the Beltsville herd and are not final for those sires having additional daughters to test. Three daughters of Oxford May's Interest Owl now on test will average 750 pounds of butterfat or better, which will raise his average materially.

TABLE 3.—*Average production (mature-equivalent basis) of the daughters of proved sires used in the Jersey herd*

Group and sire	Daughters in herd	Daughters with records	Average production		
			Milk	Butterfat	
	Number	*Number*	*Pounds*	*Percent*	*Pounds*
Raleigh:					
Karnak's Noble 4th	0	10	12, 211	5. 58	670
Tiddledywink's Raleigh	1	10	13, 603	5. 65	743
Raleigh's Dorothy's Senator	7	7	13, 838	4. 84	651
Owl-Interest:					
The Moose O'Fernwood	0	14	12, 310	5. 36	641
Oxford May's Interest Owl	4	10	11, 852	5. 52	630
Marston's Interested Owl	10	1	9, 194	5. 89	530
Sophie-Tormentor:					
Sophie's Torono 23d	1	16	12, 275	5. 38	646
Sophie's Phoenix	15	12	11, 899	5. 70	656

The Owl-Interest group now numbers 23 females, the Sophie-Tormentor group 17, and the Raleigh group 16. In addition, there are 10 females on the family crossing experiment, 6 of which are descended from 8 distinct Jersey families. One of these eight-family individuals just completed a record of 11,853 pounds of milk and 660 pounds of butterfat, starting at 2 years 4 months of age. Of the 10 animals in this family crossing project, 8 have records which average 12,711 pounds of milk and 676 pounds of butterfat, age corrected.

BULL LOANING

Young bulls from this herd are loaned for use in bull associations, and in herds owned by institutions, colleges, and individuals, where their transmitting ability for milk and butterfat production can be determined. Sixty-two Holstein and forty-three Jersey bulls are now being proved. The loaning of bulls to the institution herds in Pennsylvania is an interesting example of this work and its possibilities. A total of 19 bulls have been placed in the past 2 years, of which 16 are still in service. Eight hundred and eighty-six cows have been bred to these bulls, 334 have calved, and 159 female calves have been born. This represents a vast breeding operation, in which complete and satisfactory records will permit a thorough study of results. This undertaking should prove beneficial to all parties concerned and should produce invaluable material for studying breed development in these herds.

HEALTH AND FERTILITY STUDIES

MASTITIS TREATMENT

During the past 2 years the men handling the Beltsville herds have followed a system of treating cases of acute mastitis that has been very successful in bringing about rapid recoveries from attacks or in checking incipient attacks. About a year ago this system of treating acute mastitis was established in the Bureau's field-station herds with equally successful results.

The treatment itself is not essentially different from that followed in such cases for many years, that is, the application of heat and massage to the affected udder; nor is the method of determining the presence of the abnormal condition new. The success of the treatment appears to lie in the early discovery of the condition, followed by prompt treatment before the acute symptoms have progressed very far in the udder; with a method that permits a uniform application of heat over the udder, and maintenance of the heat at approximately the desired temperature for considerable periods of time.

A canvas bag made to fit the udder, so that when it is in place and filled with warm water the heat is applied evenly to all parts of the udder, has been found to be the most convenient and satisfactory way of applying heat. The water is put in the bag at a temperature not exceeding 110° F. and the bag remains in place from 20 to 30 minutes at each treatment. When the bag is removed the massage treatment is given.

ARTIFICIAL INSEMINATION

During the year experiments have been carried out in shipping semen via air over considerable distances for artificial insemination.

When the proper care and technique are used, artificial insemination of cows within a herd or in nearby herds appears to meet with approximately the same success as natural mating. However, when semen has been held several days and in addition transported some distance, artificial insemination has not been very successful.

Shipments of semen were made from Beltsville to the Woodward (Okla.) station on March 23 and on April 17 and 20, 1937. These shipments left Washington about 5 p. m. They were taken by airplane to a point some 200 miles east of Woodward, and thence by rail. The semen was chilled, shipped in insulated packages, but was not kept in ice boxes en route. The packages had a temperature of 69° to 71° F. on arrival at Woodward. Semen in each shipment was examined under microscope and showed activity for 2 days. Samples of the same semen kept at Beltsville showed that 70 percent of the sperm cells were still active on the fifth day, 40 percent on the ninth day, and 5 percent on the twelfth day. In all, five cows were inseminated at the Woodward station but none conceived.

Semen shipped to the Huntley (Mont.) station, on April 20 and on May 17, 1937, left Washington about 5 p. m., and arrived at Huntley at 8 a. m. the following morning. The temperature of the packages was approximately 64° F. on arrival. The first shipment, at the time of arrival, was allowed to reach room temperature and was examined for activity of the sperm cells. On the second day when a cow was to be inseminated there were no sperms showing motility. The second shipment was kept in an ice box until needed in the afternoon of the day of arrival, May 18. A cow was then inseminated that appears to have conceived. Some of the semen was kept in an ice box until May 20, when another cow was inseminated, though the semen showed no motile sperms. This cow did not conceive.

These experiments will be continued and attempts will be made to keep the semen under more constant temperature while en route.

RELATION OF CONFORMATION AND ANATOMY TO PRODUCING CAPACITY

ANTE-MORTEM AND POST-MORTEM STUDIES

The external form and internal anatomy of cows having records of production have been studied according to the practice that has been in effect for a number of years. Some of the cooperating State experiment stations have been less active than during some previous years. Three reports on cows slaughtered were prepared at the Florida station, 5 at New Hampshire, 7 at North Dakota, 3 at Pennsylvania, 4 at South Carolina, and 9 at the Beltsville station—a total of 31 for the year, which brings the total number of such reports on file to 624. The cooperating stations having submitted the greatest number of reports on cows slaughtered in connection with this project to date are: Pennsylvania with 81, South Carolina with 80, New York (Cornell) with 48, Florida with 35, North Carolina and North Dakota each with 23, and 14 other stations with numbers ranging from 14 to 2. A total of 236 reports have been prepared at the Beltsville station. New Hampshire has been added to the list of cooperating stations and has become active during the year.

A summary of all of the data filed prior to July 1, 1936, in connection with the cooperative study of the conformation and anatomy in relation to producing capacity has been prepared and published during the year. The summary is based on the study of 593 cows having records of production that have been slaughtered in connection with the project. It shows the number of reports prepared at Beltsville and at each of the cooperating stations. The data are divided into five groups on the basis of breed and the summary gives for each of 37 ante-mortem and 82 post-mortem items, the average for all animals represented, the three highest values, the three lowest values, and the averages for the heaviest, the middleweight, and the lightest cows. The summary was prepared for the information and guidance of those cooperating in the project and for the benefit of anyone interested in the study of the conformation and anatomy of the dairy cow. The summary was considered to be a preliminary tabulation, and no attempt was made to show correlations or to draw conclusions. This will be done when sufficient data are on file to warrant such a statistical study.

GROWTH, CHANGES IN BODY FORM, AND UDDER CHARACTERISTICS

Conformation-anatomy-production studies have been continued along the other lines outlined in previous reports without noteworthy change. Growth and conformation have been recorded by means of 242 new sets of body measurements on 158 animals and 353 photographs of 91 heifer and bull calves. Particular stress has been placed on the comparative study of the udders of individual females at different ages through life and after death. In this connection 270 additional observations were made of the udder development of 74 heifers from birth to 18 months of age; 490 observations of udder condition were obtained on 82 cows; udder photographs were made of 31 heifers at 18 months of age and of 83 cows; 142 timings were made on 66 cows to determine the rate at which milk can be drawn from individual cows with a milking machine; and the comparative rate of milking and quantity of production of individual quarters of the udder was determined in 16 cases on 15 cows. A manuscript has been prepared covering a detailed study of the performance of individual quarters of the cow's udder when milked simultaneously with a special milking machine that permits drawing the milk of

each of the quarters into separate containers. Comparable capacities have been measured for 21 udders, of which 14 were from cows of lactating age, 2 were from nonbreeding heifers never pregnant, 4 were from heifers that had been pregnant but never lactated, and 1 was from a freemartin. Udder-capacity data suitable for comparative study are now available for 348 udders. The average capacity for the udders of 147 lactating cows studied to date is 53.74 pounds, whereas the average for 98 nonlactating udders is 32.33 pounds. During the year the formalin-filled, frozen udders of 17 cows, 7 heifers, and 2 freemartins have been sectioned; the gross sections of the udders of 33 cows and 8 heifers have been photographed; and studies of the physical properties of the udder tissue have been made for 19 cows and 1 heifer. The growth, conformation, and udder studies are carried on continuously from year to year in connection with the breeding experiments and genetic studies of the Bureau.

NATURE'S COMPENSATION FOR THE LOST QUARTER OF AN UDDER

Some light has been thrown on the question of whether or not nature compensates for the loss of one or more quarters of the udder by increasing the activity of the remaining quarters. The case reported here was discovered in following the usual procedure of studying the structure of the cow's udder in relation to its comparative calfhood development and its subsequent producing capacity. Notes on this animal (Jersey cow no. 1074) show nothing abnormal prior to 1 year of age. In fact, at every observation except the first, the mammary-gland development appears to have been well above the average. At approximately 18 months of age the glandular development was definitely below average and a hard lump was noted in the right rear quarter. The cow calved normally but normal milk was never obtained from either of the rear quarters—both being "blind" almost from the beginning of lactation.

Production for the first lactation which commenced at 2 years 6 months of age amounted to 7,223 pounds of milk and 410 pounds of butterfat in 365 days. Sometimes, in making comparative studies of the innate producing capacity of dairy cows, as in evaluating the transmitting ability of herd sires, attempts have been made to estimate the quantity of production a cow with one or more blind quarters would have made if all quarters had been functioning normally. On an average the two rear quarters produce approximately 60 percent of the total milk yield of the udder. If one were to assume that the recorded production of this cow was only 40 percent of her innate capacity and were to make further adjustments for age, the estimate of her mature producing capacity for 365 days would be 23,294 pounds of milk and 1,282 pounds of butterfat. There is no reason to believe this cow possessed an inheritance that even approached such a high production level.

There may have been some lack of fullness in the rear quarters, but externally the deficiency did not appear to be great. When the udder was sectioned, however, it was found that the tissues of the front quarters had pushed backward and displaced a large portion of the space normally occupied by the rear-quarter tissues. In fact, the front-quarter tissues extended well to the rear of the rear teats and occupied about one-half to two-thirds of the area in a plane directly above them. In view of the findings described, it appears that there can be little doubt of the ability of nature to compensate to a large extent for the loss of one or more quarters of an udder—particularly when such a loss is experienced early in life—but there is no certainty that such compensation always occurs.

NATURE OF UDDER SWELLING AT CALVING TIME

Intense swelling of the cow's udder at calving time is frequently observed. Sometimes the swelling is so great that the udder becomes badly distorted and "plastic"—a condition in which external pressure, as with the fingertips, leaves a persistent indentation. During the year an unusual opportunity was provided for slaughtering and studying the udder structure of a cow at the time she was showing this condition to a very pronounced degree. Records indicate that the cow (no. 848) had a strong tendency to develop this condition regularly at each calving and that it was more persistent than in most cows.

In accordance with the procedure regularly followed in studying the capacity, gross structure, histology, and other characteristics of amputated cow udders, this udder was removed and weighed immediately after the cow was

killed, slaughter taking place 5 days after the fourth calving. Subsequently it was filled with formalin, sectioned for histology study, frozen, sectioned for studies of gross anatomy, and the sections so prepared were photographed. Although the udder was milked out before the cow was killed, it was found to weigh 165.65 pounds (10.88 percent of the live weight of the cow the day before her last calving). The estimated capacity of the udder, as determined by measuring the amount of formalin held by the two right quarters, was 111.72 pounds.

When the right and left halves of the udder were separated by cutting along the median septum the nature of the swelling could be seen. It appeared to be limited to a layer varying up to 2 inches in thickness located immediately beneath the skin and entirely separate from the glandular tissue of the udder. The cut surface of the swollen substance appeared to consist chiefly of a clear fluid containing a network of fine silky fibers resembling spider's web. The fluid did not escape when the incision was made but seemed to be held in suspension. Further study of the swollen substance showed that it consisted almost entirely of loosely connected fibers and that it was capable of holding, releasing, and picking up large quantities of fluid. Although this cow was a slow and comparatively hard milker, her productiveness does not appear to have been seriously hampered by the somewhat persistent swelling, as her record for 365 days, made at the age of 4 years 5 months, was 15,200 pounds of milk and 520 pounds of butterfat.

The gross sections indicated that the glandular tissues were essentially unaffected by the described swelling. This is confirmed in large measure by histological studies of mammary-gland tissues adjacent to the swollen layer. Apparently the condition described is a superficial edematous swelling that does not invade the secreting mammary-gland tissues to any appreciable extent, but is confined to the space between the glandular tissue and the skin.

FEEDING AND MANAGEMENT INVESTIGATIONS AT BELTSVILLE, MD.

CHOPPING HAY BEFORE STORING

A continuation of the work of the previous year in chopping field-cured alfalfa hay at the time of storing it in the barn showed that chopping could be done quickly and easily and that hay chopped in ¾-inch lengths occupied 40 percent as much space as similar hay that was not chopped. Hay containing 16 percent of moisture, which is probably somewhat less than most hay contains when put in storage, was stored June 3, 1936, and kept in storage throughout the summer. The chopped hay heated more than the long hay and lost more of its color and carotene. In November the chopped hay still retained 27 percent of the carotene it contained when stored, and the long hay 42 percent. Losses of the other feed constituents in the two hays were about the same and the values for milk production were approximately equal. The results of the 2 years' work point to the conclusion that storing hay in the chopped form as it comes from the field is practicable, provided the hay has a low enough moisture content and is chopped coarsely. On the other hand, if the hay has not been well dried in the field, it may heat to high enough temperatures to cause the loss of nearly all its green color and carotene; and the finer it is chopped, the higher the temperatures are likely to be, even to the point of becoming hazardous, the hay losing all its color and carotene and much of its feeding value for milk production.

BALING HAY FOLLOWING FIELD CURING

A preliminary experiment in baling freshly cured alfalfa hay as it is hauled from the field has indicated the feasibility of this practice provided the hay is not too moist, is not pressed too tightly, and the bales are piled in such manner as to permit aeration and drying. Further investigations are planned to determine the limitations of this practice.

SNOW-FENCE SILOS

Two temporary silos constructed of four sections of 4-foot, slatted, snow fence and lined with special paper were used successfully to store the surplus corn silage at the Bureau farm at Beltsville. A third silo similarly constructed but

unlined permitted too much spoilage to be considered successful. The loss of dry matter from normal fermentation and spoilage was 10 percent in the lined silo that was opened after 30 days of storage and 13 percent in the one opened after 60 days of storage. These losses are considered very moderate in view of the shallowness of the silos (14 to 15 feet) and the large surface spoilage in proportion to the total weight of silage. The edible silage appeared to be normal in every respect. The annual cost of the lined silos is estimated at 37 cents per ton of storage capacity.

CORN SILAGE AND GRAIN SUPPLEMENTS AS THE ENTIRE RATION

Ten milking cows, divided in two groups, were fed 160 days to determine the practicability of a ration containing corn silage as the sole roughage. One group received a balanced grain mixture at the full-grain rate, the grain fed averaging 1 pound for each 2.7 pounds of milk produced. The other group received cottonseed meal at the limited-grain rate, averaging 1 pound for each 5.5 pounds of milk produced. In addition both groups received all the corn silage that they would eat.

The full-grain group averaged 1,352 pounds live weight and ate 65 pounds of silage containing 20.7 pounds of dry matter per cow daily.

The limited-grain group averaged 1,206 pounds live weight and ate 74 pounds of silage containing 23.6 pounds of dry matter per cow daily.

The dry-matter content of the silage varied from 28 to 38 percent. When the data were analyzed to determine the effect of moisture content on dry-matter consumption it was found that the cows consumed an average of 9.6 percent more dry matter in the silage when it contained 65 to 69 percent of moisture than when it contained 70 to 72 percent of moisture.

The cows that received corn silage and cottonseed meal at the limited-grain rate lost more weight and declined slightly faster in milk production than the cows that were fed the silage and grain mixture at a full-grain rate. No injurious effects were observed. A ration containing corn silage as the sole roughage is practicable when supplemented with a protein concentrate. Cows that are fed silage as the sole roughage probably will not consume quite as much dry matter in the roughage as when they are fed hay and silage.

MAKING SILAGE FROM LEGUMES AND GRASSES

Further investigations into methods of making silage from the legumes and grasses appear to justify the following conclusions:

That good silage can be made from hay crops without the addition of other materials and with the use of ordinary haymaking machinery provided (1) the crop to be ensiled is allowed to lie in the swath and wilt from 2 to 4 hours after cutting on a good drying day or longer on a poor drying day, and (2) the material is finely chopped and is kept leveled off and well tramped in the silo so as to expel the air.

If feeding is not begun at once a protective covering, such as building paper or old newspapers, spread over the entire top, covered in turn by one or two loads of the wettest material available (silage material or finely chopped wet straw) and weighted down with rocks or other material, seems desirable in order to prevent excess spoilage on the top.

Partial drying of the crop in the field diminishes the losses caused by fermentation and the crop is more likely to produce a silage having a good aroma, but it increases the surface spoilage and loss of carotene. Such silage, having a higher dry-matter content, is eaten in larger quantities (dry-matter basis).

The addition of mineral acids to fresh, green material when ensiled, appears to produce a silage having a good aroma and it also lessens the loss of carotene. The addition of molasses to unwilted green material also increases the probability of producing a silage having a good aroma, and it improves the palatability slightly. The addition of acids or molasses is practicable if the farmer is intent on preserving the maximum quantity of carotene regardless of expense and trouble; but if the preservation of carotene is not a prime consideration, then wilting the crop and the thorough exclusion of air from the silage are the only conditions required to make a satisfactory product—one that is palatable, has a pleasant odor, and that will keep with a minimum loss of feed constituents.

BONEMEAL VERSUS DISODIUM PHOSPHATE

Some home-grown rations, particularly those in which the roughage is grown on soils deficient in phosphorus, appear to lack sufficient phosphorus for heavy milking cows. An experiment was conducted for 15 weeks with two readily available sources of phosphorus (steamed bonemeal and disodium phosphate) to determine their relative palatability when fed at will and the quantities of phosphorus that would be ingested from each. The cows consumed nearly two and one-half times as much phosphorus in the form of disodium phosphate as in the form of bonemeal. The unit cost of phosphorus in bonemeal, however, was somewhat less than in disodium phosphate. Further investigations are required to determine whether cows fed rations deficient in phosphorus will eat enough bonemeal when fed at will to make up the deficiency in phosphorus, and if not whether they will do so when fed disodium phosphate in a similar manner.

INPUT AS RELATED TO OUTPUT

Ten State experiment stations are cooperating with the Bureaus of Dairy Industry and Agricultural Economics to determine the quantities of feed that will yield the greatest net returns when fed to dairy cows, under different price conditions for the feed and for the product. The work is planned to continue for at least 2 years. Over 200 cows are being used continuously on this project.

In order to locate definitely the season of the year at which the most serious disturbances to milk flow occur in different sections of the United States, some 16,000 individual lactation records of cows in dairy herd-improvement associations in 12 States have been collected. These records, so far as they have been analyzed, show consistently that the highest production of milk occurs in May or June, when pasturage is at its best and when moderate temperatures prevail. They are likewise consistent in showing sharp declines following the peak months of May or June. The lowest point for the year may be reached anytime from September to December. Cows fed in the barn continuously throughout the entire year show a like trend but the difference between the high and low points is much less than for cows on pasture. Barn-fed cows show a variation from the season of the year of highest production to the season of the year of lowest production of less than 10 percent, while cows kept on pasture in the usual way may vary as much as 30 percent from high to low. This study shows that conditions in late summer and fall are the least favorable for the production of milk and that the feed supply is probably the major cause of the decline in milk flow at this time of the year. It appears that investigations having for their object the raising of the level of milk production by feeding or management, should be directed at improving the usual summer and fall feeding practices.

WORK AT THE FIELD EXPERIMENT STATIONS

GENERAL

On June 30, 1937, the seven field-station herds had a total of 465 dairy cattle, which is approximately the number on hand on the corresponding date last year. The number was maintained despite the fact that heavy disposals were made in four of the herds in order to bring the expenditures for feed within the funds available. Of the 465 head, 401 are females and 64 are bulls. In addition to the 465 listed above, there are approximately 135 bulls loaned to cooperators in the vicinity of the stations where they are being proved. Thirty-five females were disposed of for slaughter because of age, disease, or unsoundness, 23 died because of accident or disease, and 22 were transferred to other institutions as breeding animals. Three cows, surplus to the needs, were transferred from the Columbia, S. C. (Sandhill), station to the South Carolina Agricultural Experiment Station. Nineteen head were transferred from the Mandan, N. Dak., station to the Standing Rock Indian Agency, Department of the Interior, Fort Yates, N. Dak. The latter agency has agreed to furnish records on the females that did not complete production records in the Mandan herd and to care for the animals in a manner comparable to the care they received at Mandan. Most of these animals carry several direct

crosses of proved-sire inheritance, and should make valuable foundation cows from which to build up a high-producing herd for the Indian agency.

In the breeding experiments, 61 cows and first-calf heifers completed official production records during the year, averaging 11,292 pounds of milk and 456 pounds of butterfat at an average age of 2 years 10 months. Calculated to a mature basis, these 61 records average 14,002 pounds of milk and 565 pounds of butterfat. Fourteen of the records were made at the Huntley, Mont., station; 15 at Mandan, N. Dak.; 4 at Hannibal, Mo.; 5 at Lewisburg, Tenn.; 14 at Columbia (Pontiac), S. C.; and 9 at Woodward, Okla. Official testing has not been resumed at the Jeanerette, La., station because of the nasal disease that has been prevalent in the herd.

The roughage-feeding project reported in considerable detail in last year's report has been continued at all of the stations and several additional cows have completed records on this system of feeding.

During the year a detailed study was made of the breeding or fertility records of 20 proved sires that have been used in the field experiment station herds, to determine, if possible, the effect of advancing age, frequency of service, effect of season of the year and effect of moving on the fertility of older sires. These data have been prepared for publication. The average period of fertile service for the sires was 3 years 7 months, the shortest period of fertile service being 8 months, while the longest was 11 years 2 months. A total of 3,710 services, of which 3,083 were services to fertile cows, were recorded. The total number of conceptions was 1,250 or a ratio of 2.5 services per conception. There was, however, great variation in fertility among the sires, with a low of 4.7 services per conception for one sire and a high of 1.4 services per conception by another sire. There was a trend toward a decline in fertility as age advanced from 5 to 13 years or more. Season of the year had little if any effect on the fertility of the sires. Variation, on all the points studied was so extreme among the individual sires that averages were considered of little significance.

MANDAN, N. DAK., STATION

The year 1936 was the most unsatisfactory for crops and pasture since the station was established in 1927. Only 3 tons of alfalfa hay and 20 tons of silage were produced on the 160 acres devoted to growing feed crops. The native grass pasture furnished but little grazing. Very little feed was produced in the 2 previous years and all of the reserve feed had been exhausted. The herd now is made up almost entirely of first-calf heifers and younger females. This condition has seriously interferred with investigational work.

Nineteen bulls are now loaned to cooperators in the vicinity of Mandan where they are being proved.

HUNTLEY, MONT., STATION

The project on cost of producing nutrients in alfalfa hay, corn silage, barley, and irrigated pasture has been continued. For 1936 the yields per acre and costs per 100 pounds of total digestible nutrients were as follows:

Crop, and yield per acre:	*Cost per 100 pounds of total digestible nutrients*
Corn silage, 7.396 tons [1]	$2.03
Corn silage, 7.848 tons [2]	1.32
Alfalfa, 4.522 tons [1]	.78
Alfalfa, 3.797 tons [2]	.42
Barley, 44.3 bushels [2]	1.68
Irrigated pasture, 250 cow-days [2]	.29

[1] Field irrigated with a pump.
[2] Field irrigated by gravity.

The cost figures for 1936 are considerably higher than those for former years because heavy grasshopper infestation in 1936 reduced the yields considerably while the operating expenses remained about the same.

The experiment to compare yield, effect on stand, and the feeding value for dairy cattle of alfalfa hay cut at the initial-bloom, half-bloom, and full-bloom stages was continued. In the 1936 season the hay cut at the initial-bloom stage yielded 3.78 tons per acre; that cut at the half-bloom stage, 3.95 tons per acre, and that cut at the full-bloom stage, 3.68 tons per acre.

The six cows (divided into three groups) that are being fed on the alfalfa hay cut at these three stages of maturity to determine their feeding values have each completed a 365-day lactation. These cows were fed hay alone throughout the year. Those fed the initial-bloom hay consumed an average of 39 pounds per cow daily, as compared to an average daily consumption of 37 pounds for the half-bloom hay, and 38 pounds for the full-bloom hay. The cows fed the initial-bloom hay produced considerably more milk and butterfat than the cows in the other two groups and maintained their body weight better. This experiment is being continued.

In the breeding experiment, 14 daughters of the proved sire U. Neb. Klaver King 388329 have now completed official records. Calculated to a mature basis, these records average 18,989 pounds of milk, 3.55-percent butterfat, and 674 pounds of butterfat. The 14 respective dams under comparable conditions produced an average of 17,010 pounds of milk, 3.63-percent butterfat, and 617 pounds of butterfat. There remain in the herd eight more daughters of this sire that are on test or are yet to freshen. This sire apparently had in his hereditary make-up, to an unusual degree, both the factors that determine high levels of production and those that determine good type in his progeny. His daughters have been splended producers and have possessed a uniformly good type. Unfortunately this good sire had to be disposed of when 13 years old because of paralysis in the hind quarters.

The bull-loaning and proving work has continued without interruption. Forty-four sires are now loaned to cooperators. A new four-sire unit was started with four cooperators near Bozeman, Mont. One sire that was proved during the year was sent to the Woodward, Okla., station for use in that herd.

WOODWARD, OKLA., STATION

Three groups of heifers were carried through a 100-day feeding trial to see whether normal growth could be obtained on rations restricted to silage for roughage and limited amounts of cottonseed meal. Group 1 was fed sorgo (Sumac) silage ad libitum with 2 pounds of cottonseed meal per animal per day. Group 2 was fed sorgo silage ad libitum with 1 pound of cottonseed meal per animal per day. Group 3 (check) was fed the standard ration fed to heifers at this station, consisting of sorgo silage ad libitum, 6 pounds of alfalfa hay per day, and 2 pounds per day of a home-mixed grain mixture.

Group 1 consumed an average of 86.8 pounds of sorgo silage per head daily in addition to the 2 pounds of cottonseed meal, and averaged 1.9 pounds gain in body weight. Group 2 consumed an average of 74.5 pounds of sorgo silage per head daily in addition to the 1 pound of cottonseed meal, and gained an average of 1.3 pounds per day. Group 3 consumed an average of 50.9 pounds of sorgo silage per head daily in addition to the 6 pounds of alfalfa hay and 2 pounds of grain, and gained an average of 1.4 pounds per day.

Group 1 consumed 1,187 pounds of total digestible nutrients daily per 100 pounds of body weight, as compared to 1,105 pounds and 1,319 pounds for groups 2 and 3, respectively. The results indicate that dairy heifers over 1 year of age, that have been accustomed to eating large quantities of silage, have the capacity to consume a sufficient quantity of sorgo silage to make satisfactory gains where the silage is supplemented with a protein concentrate. The feed cost per 100 pounds of gain in group 1 was $13.27; in group 2, $15.86; and in group 3, $15.77.

A new herd sire, Klaver Gerben Ormsby Paul 650650 was sent to the Woodward station from the Huntley, Mont., station where he was bred. He was proved in a farmer-cooperator's herd. His first eight daughters to freshen averaged 14,958 pounds of milk and 559 pounds of butterfat (mature basis). The eight dams of the daughters averaged 14,550 pounds of milk containing 505 pounds of butterfat. Three daughters excelled their dams in milk production, six in percentage of butterfat, and five in butterfat production.

JEANERETTE, LA., STATION

The nasal disease which has been prevalent in the herd for several years shows some improvement, though there are still about 11 animals in the herd that are affected. Some of these animals have the disease in rather a mild form. The treatments that have been tried do not appear to have been very beneficial. Heifers kept in the barn or lots and not allowed on pasture before

they are 18 months of age have not contracted the disease. Infected cows that have been fed on hay rations and have not been pastured do not appear to be affected so severely during hot weather as the cows that are on pasture. Apparently the disease is contracted in some manner from the pasturage. Experiments are being carried out this summer that should determine more definitely whether the disease is contracted while the animals are on pasture.

The bull-loaning project has been discontinued because of the nasal disease in the herd, but several bulls that were loaned prior to the discovery of the disease are still in the hands of cooperators for proving. Since this station was established, a total of 42 bulls have been loaned to cooperators. Dam-and-daughter comparisons are now available on 17 of these sires, which afford an idea of their transmitting ability.

Table 4 gives the average production of the daughter-and-dam pairs of these 17 Jersey sires.

TABLE 4.—*Average production of the daughters of 17 Jersey sires loaned by the Jeanerette station for use in nearby herds, compared with the production of the dams of the daughters*

[All records calculated to mature basis]

Sire no.	Daughter and dam comparisons	Daughters			Dams			Increase (+) or decrease (−) of daughters over dams		
		Milk	Butterfat		Milk	Butterfat		Milk	Butterfat	
	Number	*Pounds*	*Percent*	*Pounds*	*Pounds*	*Percent*	*Pounds*	*Pounds*	*Percent*	*Pounds*
9	29	6,701	4.67	313	6,322	4.65	294	+379	+0.02	+19
13	24	5,736	4.79	275	5,296	4.94	261	+440	−.15	+14
18	23	4,427	5.07	226	4,890	4.77	233	−463	+.30	−7
21	1	5,059	4.86	246	4,786	4.35	208	+273	+.51	+38
33	54	8,722	4.33	377	7,147	4.48	321	+1,575	−.15	+56
34	4	4,154	4.81	200	3,096	5.23	162	+1,058	−.42	+38
35	9	4,897	5.03	246	6,085	4.78	291	−1,188	+.25	−45
45	2	8,517	5.20	443	6,716	5.31	357	+1,801	−.11	+86
48	29	4,560	4.52	206	5,064	4.36	221	−504	+.16	−15
53	23	6,591	5.25	346	7,240	4.82	349	−649	+.43	−3
54	14	8,624	5.02	433	7,075	4.58	324	+1,549	+.44	+109
58	10	5,128	5.54	284	4,543	4.95	225	+585	+.59	+59
59	24	8,837	4.16	368	6,158	5.12	310	+2,679	−.96	+58
62	3	5,959	5.27	314	5,342	4.70	251	+617	+.57	+63
64	8	6,860	5.02	344	6,070	4.81	292	+790	+.21	+52
80	11	7,330	5.08	372	7,125	5.03	358	+205	+.05	+14
82	29	7,798	5.06	395	7,318	4.93	361	+480	+.13	+34
Weighted average	297	6,845	4.79	328	6,246	4.74	296	+599	+.05	+32

In several of the herds the records were made under poor conditions and in many cases the daughters and dams were dried off early in the lactation period. The daughters of 13 of the sires were superior to their dams in both milk and butterfat production.

An interesting point in connection with the bulls in table 4 is the fact that bulls 9, 33, 54, 53, and 82 were all used and proved in the herd of the State Normal College, Natchitoches, La. These five bulls were used in the rotation given and the entire herd is now made up of their offspring, many of the younger females in the herd carrying the inheritance of all five sires. The college herd is the first ranking herd in the State in dairy herd-improvement association testing.

Sweet's Raleigh Boy 279769, a proved Jersey sire, was purchased and shipped to the Jeanerette station in September 1936. Twelve daughters of this sire averaged 9,145 pounds of milk and 491 pounds of butterfat as compared to an average of 8,298 pounds of milk and 396 pounds of butterfat for their dams. This is an increase for the daughters of 10 percent in milk and 24 percent in butterfat production. Fifteen cows are now safely in calf to the services of Sweet's Raleigh Boy.

COLUMBIA, S. C. (SANDHILL), STATION

The grazing experiments with annual crops and permanent pasture have been continued. In the annual-crop grazing experiment the winter-spring crops (a mixture of oats, barley, rye, and vetch) produced 686 pounds of total digestible nutrients per acre and the cows grazing these crops produced at the rate of 1,423 pounds of milk (converted to 4 percent butterfat basis) per acre. The summer grazing crop (a mixture of soybeans and pearl millet) produced 1,333 pounds of total digestible nutrients per acre and the cows grazing the crop produced at the rate of 2,920 pounds of milk per acre. The combined production on the winter-spring and summer-grazing crops was 4,343 pounds of milk per acre, and the yield of total digestible nutrients was 2,019 pounds per acre. This amount of total digestible nutrients is equivalent to the amount in 4,013 pounds of alfalfa hay and is considerably in excess of the previous 3-year average yield of the annual grazing crops.

The permanent pasture produced 968 pounds of total digestible nutrients per acre or an alfalfa-hay equivalent of 1,924 pounds which was somewhat less than the preceding 5-year average.

Through the cooperation of the South Carolina Experiment Station 105 samples of grazing crops taken at different periods throughout the growing season and covering the period 1933–36 have been analyzed.

Grazing data are being obtained on *Zoysia japonica* (Korean lawngrass). A small area was planted in the main pasture several years ago and it has gradually spread until the area now covers approximately 1 acre. It has made a heavy growth on the sandy soil. The 1-acre tract of Korean lawngrass was fenced in order to find its carrying capacity. Observations in the past have indicated that the grass might not be palatable but it appears that cows will eat it when they become accustomed to it and other grass is not available.

A new herd sire, Saugerities Royal Sequel 159031, was purchased and added to the herd. He has 14 tested daughters that average 14,672 pounds of milk and 767 pounds of butterfat, calculated to a mature basis. The 14 dams of the daughters average 13,665 pounds of milk and 755 pounds of butterfat. Eight of the daughters excel the dams in milk production and 9 in butterfat production. Cathedral Rosalie 334299, a daughter of Saugerities Royal Sequel, recently made a world's record in butterfat production for the Guernsey breed. She produced 23,715 pounds of milk and 1,213 pounds of butterfat in 365 days. Saugerities Royal Sequel is now being used on the daughters of the first two proved sires used at this station and he is the third proved sire to be used. Sixteen cows are now safely in calf to his services.

Gallant Cavalier 83960, a former proved sire, was slaughtered because of sterility at 14 years of age. Eleven bulls are now loaned in cooperators' herds, where they are being proved.

LEWISBURG, TENN., STATION

An experiment started in 1933 to extend the grazing season on permanent pastures, by seeding crimson clover at the rate of 15 pounds per acre each fall on pasture sod, has proved successful. Good stands and growth have been obtained each year. All seedings made during the first 2 weeks in October have made luxuriant growth. The areas seeded to crimson clover have given 5 weeks earlier grazing than contiguous areas not seeded to crimson clover and the period of good grazing in the fall has also been extended approximately 5 weeks. It also appears to have a desirable effect on the pasture sod after the crimson clover has been grazed off. It has proved to be very palatable and the cows appear to prefer the crimson clover to any other grass in the pastures. The cost of seeding, including seed and labor, has been approximately $1.30 per acre. Other experiments are planned to obtain additional information on the value of the crimson clover under different methods of handling. Several hundred people visited the station in the spring to observe the crimson clover.

The yields of roughage crops grown on the farm were lower in 1936 than in 1935. Sixty-five acres in alfalfa produced 1.25 tons per acre as compared to an average yield of 2.47 tons per acre for 41 acres in 1935. Korean lespedeza yielded 0.96 ton per acre, slightly less than in 1935; 27 acres of Sudan grass cut for hay yielded 1.67 tons per acre; Otootan soybeans averaged 2.14 tons of hay per acre; orchard grass, 1.50 tons per acre; and mixed grasses and lespedeza, 0.86 ton per acre.

21546—37——3

Approximately 175 tons of hay were dried in the mechanical hay drier during the year, consisting of 73 tons of alfalfa, 53 tons of lespedeza and grain mixed, 18 tons of soybeans, and 31 tons of Sudan grass. Thirty-five tons of the machine-dried hay were shipped to the Beltsville station.

The roughage feeding experiment, in which Jersey cows are fed a ration of machine-dried hay and pasture with no grain for entire lactation periods, has progressed to the point where there are 16 records made under this system of feeding that are comparable to records made by the same cows in another lactation period when they received a full-grain ration. The 16 records on roughage alone average 6,333 pounds of milk and 329 pounds of butterfat, which was 67 percent as much milk and 62 percent as much butterfat as the same cows produced when fed grain in addition to roughage.

Holger St. Mawes Noble 230503 was disposed of because of sterility. He was purchased in 1930 as a proved sire. In 1933 he was injured and since that time has had but limited service. He has 15 daughters in the herd, only 4 of which have completed production records. These four average 9,388 pounds of milk and 530 pounds of butterfat (mature basis) as compared to an average of 9,647 pounds of milk and 528 pounds of butterfat for their dams. Holger St. Mawes Noble has a total of 31 tested daughters, that have records averaging 13,619 pounds of milk and 782 pounds of butterfat.

HANNIBAL, MO., STATION (THE HATCH FARM)

Four Jersey cows are now on an experiment in which they are fed a ration of roughage alone (hay, silage, and pasture) for entire lactation periods. They have been in milk for an average of 165 days and have produced an average of 5,782 pounds of milk and 284 pounds of butterfat. One cow has produced 332 pounds of butterfat in 160 days and another has produced 304 pounds in 179 days.

Progress Owl's Pilgrim, a silver medal proved sire, was purchased and is now in service in the herd. He is the fifth proved sire to be used in the Hatch Farm herd. Nine daughters of this sire, when milked twice a day for 305-day records, produced an average of 619 pounds of butterfat, calculated to maturity. The dams of these daughters under similar conditions produced an average of 542 pounds of butterfat. The daughters excelled the dams by 14 percent.

A group of dairymen in the vicinity of Vinton, Benton County, Iowa, applied for the loan of young bulls and four have been placed there.

Records kept of the cost of growing feed crops show that for the 1936 season corn silage with a yield of 4.3 tons per acre was grown at a cost of $3.25 per ton. Five acres of alfalfa seeded in 1935 yielded at the rate of 2.2 tons per acre at a cost, including preparation of the land and seeding, of $35.17 per acre or $15.99 per ton. If the cost of preparing the land and seeding is not included the cost was $2.10 per ton. Assuming that the stand would last for 5 years, the cost of seeding and preparation of the land should be divided over the 5-year period. In this case the cost per ton for 1936, including a proportionate share of the preparation and seeding costs, would be approximately $4.90 per ton. In calculating the above costs, a man-hour of labor was figured at 20 cents, a horse-hour of work at 10 cents, and tractor costs at 50 cents an hour. Interest, taxes, and upkeep on land and equipment are not included.

WESTERN WASHINGTON EXPERIMENT STATION

Experimental work in dairy-cattle breeding and feeding in cooperation with the Washington Experiment Station has been underway at the Western Washington Experiment Station for several years. Two projects are being completed at this station that have attracted the attention of dairy farmers in western Washington. One is the preservation of grass silage in a modified combination form of the stack and trench silos. For these experiments a pit or trench was dug 14 feet wide, 40 feet long, and 2½ feet deep. Grass, and oats and peas, have been ensiled in both the chopped and the unchopped form. The material is put in the pit and built up to a height of approximately 10 feet above the ground level. The dirt removed from the pit is then placed on top of the stack to a depth of approximately 18 inches for the purpose of weighting and sealing the stack. By the time the stack is opened the material has settled until the height of the stack is less than 4 feet above the ground level. The results of this work over a period of years, giving the loss of dry matter as

compared to that in an upright silo, are being published by the Washington Experiment Station.

The second experiment that is being concluded is one in which three groups of seven cows each were fed over a period of years on rations consisting of pasturage during the grazing season and field-cured hay alone during the balance of the year, or silage alone, or grass and hay. No grain was fed. In addition to production and reproduction records, which will soon be completed and analyzed, the color and carotene content of the rations fed and the relation of these rations to the color, carotene, and vitamin A activity of the butterfat produced by the cows on these rations, have been analyzed and prepared for publication. The results indicate that over a 3-year period the average carotene content of rations of home-grown hay, grass hay and grass silage, grass silage, and pasture were 15, 57, 197, and 259 micrograms per gram of dry matter, respectively. When fed to Holstein cows they produced butterfat with an average carotene content of 3.6, 6.5, 6.8, and 7.9 micrograms per gram. The cows receiving the hay ration secreted on the average of 0.72 percent of the ingested carotene in the butterfat; those receiving hay and silage, 0.23 percent; and those receiving silage alone, 0.14 percent.

DIVISION OF NUTRITION AND PHYSIOLOGY

E. B. Meigs, *in charge*

RELATION BETWEEN DIET AND FECUNDITY

Considerable loss to the dairy industry results from irregularities in reproduction; and it is important to know whether such irregularities are the result of heredity or of faulty nutrition, and to what extent.

In studying the effect of a certain nutritional regime on fecundity or lactation, it must be borne in mind that its full effect may not be obvious in an experiment extending over a single generation. This is particularly well illustrated in the work with rabbits on ordinary cattle rations at this station. When such animals are fed limited amounts of grain and U. S. No. 1 alfalfa hay at will throughout four generations they show no decrease in fecundity or in their capacity to rear their young; whereas, when they are fed No. 3 alfalfa hay instead of No. 1 alfalfa hay these functions are impaired somewhat in the first generation, much more so in the second, with almost complete failure in reproduction and in lactation in the third generation. As previously reported, with No. 3 timothy hay there was complete failure in reproduction in the second generation. These results also indicate that good-quality hays contain something that promotes fecundity and lactation that is deficient in the hays of poorer quality. Efforts to supplement these deficient rations with carotene, yeast, minerals, cod-liver oil, milk, liver preparations, and vitamin C have not resulted in normal reproduction, although a solution of carotene in cottonseed oil appeared to be definitely helpful.

During the past year a survey was made of the reproduction records of the cows used by this Division in nutrition investigations at Beltsville. The abnormalities most frequently observed were as follows:

(1) Those abnormalities in reproduction in which the cow conceives but, although she is free from infectious abortion, calves somewhat prematurely and gives birth to young that are dead or blind or so weak that they soon die. This difficulty, described in previous reports, is due to a deficiency of vitamin A in the ration. It does not occur with animals that have recently been on good pasture, nor with animals on dry rations of grain and hay that supply adequate amounts of vitamin A.

(2) Those irregularities in reproduction in which the heat period has not appeared at the usual intervals. In the great majority of such cases, this condition has been due to an abnormally persistent corpus luteum, and has been corrected when the corpus luteum was ruptured. Cases in which irremediable failure to come in heat have occurred have been extremely rare in this herd. The cause of an abnormally persistent corpus luteum in cattle apparently is unknown. In a few instances in the herd, the abortion of very small immature fetuses has been observed.

(3) Another type of difficulty in reproduction that is frequent in this herd is what may be called temporary sterility or "shy-breeding" (i. e., cases in which cows come in heat regularly, but require several services before they conceive).

In the present work the number of services necessary to produce pregnancy was determined with cows on rations consisting of approximately equal proportions of (1) grain and U. S. No. 1 alfalfa hay, (2) grain and either U. S. No. 3 alfalfa hay or No. 3 timothy hay, and (3) grain and No. 1 alfalfa hay in the winter and pasture in the summer. A similar study was made with 15 cows that had become shy breeders (bred five or more times without conceiving) while receiving winter rations on pasture, and of the effect of pasture in the diet of the dam upon the fertility of her daughters when bred for their first calves.

The results in this survey seem to favor the view that shy-breeding (temporary sterility) and permanent sterility in cattle are more likely to develop on barn rations than on pasture, that shy-breeding may often be corrected by periods on pasture, and that permanent sterility is likely to be caused by certain highly deficient rations. It seems in such cases that there may be a gradual degeneration of some part of the reproductive system. As in the case of the rabbit, the tendency to decreased fecundity by cows on deficient rations is likely to become more marked in succeeding generations. Also, as with the rabbit, this difficulty in reproduction with the cow does not appear to be due particularly to a deficiency of vitamin A in the ration, may occur on rations which would appear to be adequate in this respect, but is in general more pronounced on the same rations that are poor in this factor. The results, when considered as a whole and in conjunction with those on rabbits and rats here, and in other laboratories, indicate that optimum fecundity in mammals is dependent upon their receiving a very complete ration and that deficiencies in various nutritive essentials are likely to manifest themselves in decreased fecundity in the adult just as they manifest themselves in decreased growth with immature animals.

VITAMIN A REQUIREMENTS OF DAIRY COWS

The vitamin A requirement of an animal, like its energy or protein requirement, varies not only in respect to the function for which it is fed, but also as a result of variations in the rest of the dietary. Different laboratories, working with dairy cattle, have determined the amount of carotene (or vitamin A) required to prevent night blindness, or to prevent observable abnormal symptoms in the retina of the eye, or to bring about certain levels of carotene in the blood plasma or in the butterfat, or to bring about normal reproduction as determined by the condition of the new-born calf. The requirements as determined in these various ways differ; and considerable work is necessary to correlate the results, as well as to determine the effect of the various rations on the efficiency with which the carotene may have been assimilated.

The first definite symptom of vitamin A deficiency in cows that was observed by this Division and which materially interfered with the cow's usefulness, was the production, somewhat prematurely, of abnormal calves. This was with cows that were free of infectious abortion. Work has been in progress here for several years to determine the quantity of carotene needed to prevent this condition. The incomplete results indicate (1) that a ration containing 9 or 10 milligrams of carotene per kilogram of dry weight and consisting of equal proportions of grain (wheat bran, yellow corn meal, and soybean and cottonseed-oil meals) and either alfalfa, timothy, or clover hay supplies enough vitamin A for normal reproduction; (2) that 7 milligrams per kilogram in such rations is questionable; and (3) that smaller quantities of carotene lead invariably to the production of calves that are either blind, dead, or so weak they soon die.

There is apparently a large waste of carotene by the cow. However, this does not appear to be due to a destruction of carotene in the paunch; and large quantities of this pigment appear to be excreted unchanged in the feces.

VITAMINS IN CALF FEEDING

Butterfat is an exceedingly complex mixture and it is a question as to what constituents in it are actually essential in the feeding of the calf, and how to supply them with materials that are less desirable in the human dietary.

Recently this Division reported that, if calves are allowed to suckle their mothers for two or three days after birth, it is unnecessary to feed them any more whole milk if instead they are fed skim milk supplemented with some

suitable source of vitamin A, such as carotene in oil or a very small amount of cod-liver oil. By the time such calves are 6 months old, their gains in weight are as great as those of calves that have been fed whole milk for a month and skim milk thereafter until completely weaned; during the first month on the supplemented skim-milk ration, however, some calves appear to be somewhat undernourished. It has now been found that this condition can be entirely overcome by increasing the daily allowance of skim milk so as to make the energy consumption more nearly equivalent to that when whole milk is used. It has also been demonstrated that up to 6 months of age it is immaterial whether these calves have access to grain with U. S. No. 1 alfalfa hay or to grain with No. 3 timothy hay; and that after this period the gains in weight are almost as great with the timothy as with the alfalfa hay, provided the timothy hay ration fed after weaning is still supplemented with some source of vitamin A such as carrots or cod-liver oil. At 2 years of age, the animals on the supplemented timothy hay ration weigh only about 5 or 10 percent less than those receiving the alfalfa hay.

With the supplemented skim-milk rations, in the above experiments, it appeared at first also to be immaterial whether the supplement was carotene or cod-liver oil. The calves in these early experiments were exposed to daylight as under ordinary practical routine conditions. It has now been found that with the amount of carotene supplement (15 mg daily of a commercial preparation in oil) that was used in these experiments, the calves do better under these conditions than when kept in box stalls in a corner somewhat distant from windows, with a considerable portion of the light that comes into the barn excluded by canvas curtains extending up to about 5 feet from the floor. Growth, under the latter conditions, however, is improved either by trebling the amount of the carotene supplement or by feeding a few drops of viosterol daily as a source of vitamin D. It appears that the smaller amount of carotene may be inadequate for maximum growth; and that, possibly, under these unusual conditions of lighting, additional vitamin D in the ration is also needed.

In most of this work with calves, when cod-liver oil has been used as the supplement, 20 ml daily has been fed. Calves, which otherwise would have died as a result of a deficiency of vitamin A in their diet have, when fed this amount of this supplement, survived, grown normally, and calved without difficulty. Animals have likewise survived and have been raised to 18 months of age on as little as 10 ml per day of this supplement. The cod-liver oil that has been used has contained close to 800 micrograms of vitamin A per gram. No toxic symptoms have been observed with it at any age with calves receiving doses of 40 grams per day or of 0.5 gram per kilogram of body weight. Calves may suffer from an overdose of cod-liver oil as stated in a previous report. The muscle tissues of some calves that have been poisoned here in this way, have been examined in the laboratory of animal nutrition at the New York (Cornell) Agricultural Experiment Station. The results indicate that calves are not as sensitive to cod-liver oil toxicity, and apparently do not have the tendency (at least not as great a tendency) to develop dystrophy of the skeletal muscles as has been observed with the goat, sheep, and rabbit.

On account of its sensitiveness to the toxic effects of cod-liver oil, the rabbit has seemed a very suitable animal in which to study the cause of this toxicity. Work in other laboratories has shown that the toxic effect is largely, if not exclusively, associated with the saponifiable fraction of the oil. Results in this laboratory on the toxicity of calciferol are in harmony with the view that this toxicity is not caused by the factor that renders the oil antirachitic. Cod-liver oil (1 ml per day) and calciferol (0.02 mg per day with some of the animals) are toxic with rabbits on basal rations consisting of a grain mixture with hays of poor quality. As judged by the length of time the animals survived, the cod-liver oil was much more toxic per unit of antirachitic activity than the calciferol, and the toxic symptoms were quite different. The calciferol produced an extensive impregnation of the soft tissues of the body with lime salts, instead of the characteristic degeneration of the skeletal muscles that occurred with the cod-liver oil.

In this connection, it is of interest to call attention again to the fact that, at least with rabbits, the toxicity of cod-liver oil is counteracted by feeding a good grade of alfalfa hay, and further that, as was first shown elsewhere, wheat-germ meal has a counteracting action. The work here also

agrees with that done elsewhere in showing that shark-liver oil has no toxic effect when fed to rabbits, but rather is helpful in some respects, improving possibly to some extent their fecundity and lactation.

MASTITIS IN RELATION TO METHOD OF MILKING

In 1934 there was an epidemic of mastitis in the herd used in the Bureau's nutrition experiments. Forty-nine cows were in milk and all but one showed clots at some time on the strip cup; 36 of these cows each had one or more quarters in which this test indicated a severe mastitis; some of the cows went dry early in lactation; and the nutrition experiments in this herd were being materially disrupted.

The epidemic had followed soon after certain changes were made in the methods of milking. Therefore, in January 1936, a study was begun of the effect of different procedures of this sort. The results up to the present time indicate that it is quite likely that the incidence of mastitis may possibly be influenced largely by practices used in milking. This study is being made in cooperation with the Division of Dairy Research Laboratories, and is discussed further in the report of that Division.

MINERALS IN CATTLE FEEDING

Some years ago the Bureau began an experiment to determine the effect on the health, reproduction, and production of dairy cattle, of feeding, over long periods of time, rations that were very low in their calcium content and which, according to the data at hand, would not be expected in other respects to promote the assimilation of calcium and phosphorus. These rations led to premature calvings and abnormal calves, not because of their deficiency in calcium; but, as is now known, because they did not supply sufficient vitamin A. Another experiment has been in progress now for several years, with cows and growing stock, to determine whether or not, when the vitamin A deficiency in such low-calcium rations is supplied by feeding either cod-liver oil or carrots, a mineral supplement is helpful. The experiment has not progressed far enough with the cows to report the results; but with the younger animals very nearly the same gains in weight have been noted, in the work so far, with the groups with and without bonemeal in their ration.

CAROTENE CONTENT OF ROUGHAGES

Carotene analyses, as a measure of the vitamin A potency, have been made of all the hays fed to the cattle used in the Bureau's nutrition experiments in the last few years. These hays have also been graded by representatives of the Hay, Feed, and Seed Division of the Bureau of Agricultural Economics. Although the carotene in the growing plant occurs mainly in the leaves, the greenness of hays, rather than their leafiness, is a more important index of the amount of carotene in them.

Table 5 shows the relation between the color and carotene content of the market hays analyzed up to the present time.

TABLE 5.—*Carotene content and color of market hays*

Kind of hay	Percentage of natural green color	United States grade, based on color alone	Lots analyzed	Carotene content	
	Percent		*Number*	*Milligrams per kilogram*	*Milligrams per kilogram*
Alfalfa	60 or more	No. 1	26	19–121	44
	35 and less than 60	No. 2	6	11– 20	15
	Less than 35	No. 3	10	1– 11	4
Timothy	45 or more	No. 1	10	[1] 8– 36	20
	30 and less than 45	No. 2	3	8– 11	9
	Less than 30	No. 3	20	1– 12	5

[1] There was 1 exceptional U. S. No. 1 timothy hay with a carotene content of 8 mg per kilogram. It was graded 47 percent in greenness. The carotene content of the other 9 lots of No. 1 timothy hay varied from 16 to 36 mg per kilogram.

When alfalfa hays are stored in a dark, unheated building, the rate of loss of carotene is practically the same whether they are ground fine enough to pass through a ⅛-, ¼-, or ¾-inch mesh, or stored in bales; and, also, with baled samples the rate of loss during storage was practically the same for alfalfa, timothy, and clover. For average outdoor temperatures of 45° F. or less, and of 45° to 66°, the losses of carotene per month were 3 and 6.5 percent, respectively. At higher temperatures the loss varied from 11 to 21 percent per month, depending on length of the previous storage periods.

Work has been done during the year on the sources of error in the determination of the carotene in hays. Carotene is extracted very completely (97 percent) in most methods of analysis; the loss in separating it from chlorophyll and xanthophyll by various modifications of the Willstätter and Stoll procedure is negligible (possibly 2 percent); and the work in this laboratory would indicate that, when 92-percent methanol is used in this process, the xanthophyll is very completely (99 percent) removed from the carotene. By far the greatest error in the determination of the carotene in hays and silages is due to the presence of other pigmented impurities that go with the carotene in these separations. With U. S. No. 1 alfalfa hays, these impurities may, on an average, account for approximately 15 percent of the absorption of light at the wave length 450 mμ. With No. 3 alfalfa hay, No. 1 timothy hay, No. 3 timothy hay, and corn silage, the corresponding figures are 33, 24, 40, and 30 percent, respectively. In this work the carotene and pigmented impurities were separated by a method of adsorption which did not appear to alter these pigments.

THE MEASUREMENT OF THE VITAMIN A POTENCY OF BUTTER

The vitamin A activity of butterfat is due to two constituents—(1) the yellow pigment called carotene in it, which may be converted into vitamin A in the animal body, and (2) to a very nearly colorless material that is vitamin A itself. The vitamin A potency of butter has been determined in two ways—(1) biologically and (2) chemically by determining separately the amounts of carotene and vitamin A present and calculating the potency from these results. With butter the results, by these methods, have not agreed well; and, although the biological procedure is long, expensive, and not subject to any considerable degree of precision, the chemical results are subject to some uncertainty in interpretation, as no very conclusive evidence appears to have been presented to show the accuracy with which the spectral absorption at wave lengths of 325 mμ to 328 mμ (corrected for carotene or for carotene and xanthophyll) actually represents vitamin A. In fact some butters from cows on rations very low in vitamin A show very little evidence of any selectivity in absorption (corrected) in this region of the spectrum, although the slope of the light-absorption curve toward the longer wave-length side of this region resembled that of vitamin A. Attempts to separate the materials in butters that absorb light at wave lengths of 325 mμ to 328 mμ, however, have so far yielded evidence in favor of using the corrected light absorption in this region as a measure of the colorless vitamin A in the butter. The work is being continued.

Different carotenes vary in the efficiency with which they may be used as a source of vitamin A. Some laboratories have found only beta-carotene in butterfat; others report the presence of both alpha- and beta-carotene. Both of these pigments have been found here in butter from cows that were being fed considerable quantities of carrots, which contain both of these carotenes.

PHYSIOLOGY OF REPRODUCTION

In the study of the physiology of reproduction in cooperation with the Bureau of Animal Industry notable progress has been made during the year. Male sex hormone has been found in the urine of bulls and rams. The procedure for its assay with rats has been improved. Preliminary work has indicated that there is a considerable variation in the quantity of this hormone in urines from different bulls, and work is continuing along this line. It has been shown that when synthetic male hormone is administered to normal rats in very large quantities, it stimulates the prostate, but leads to a decrease in the weight of the testes. Work is in progress on the relation of the histology of the anterior lobe of the pituitary gland of cattle to the reproductive processes.

DIVISION OF DAIRY RESEARCH LABORATORIES

L. A. Rogers, *in charge*

CHEMISTRY AND BACTERIOLOGY OF MILK

In accordance with the long-established policy of the laboratory, studies have been made as circumstances permitted on some of the more obscure chemical and physical relations of the constituents of milk. These relations are of interest as they affect the stability of the milk under changing conditions of temperature and chemical reaction, and as they influence the nutritive value of the milk and the flavor and the deterioration of products made from it.

Potentiometric titrations have been made on 0.1 molal solutions of citric acid, monocalcium citrate, dicalcium citrate, and tricalcium citrate, and both titration curves and buffer curves constructed. An exact comparison of these curves with the theoretical curves is not possible because of the uncertainty of the effect of ionic concentrations on the dissociation constants of citric acid and of calcium citrate, but the two sets of curves are in sufficiently close agreement to support the McLean and Hastings theory of the stepwise dissociation of calcium citrate. A paper covering this work is being prepared for publication.

Following the completion of the investigation of the composition of the phospholipids of milk, work has been started on the fatty acids. Approximately 11 kg of esters have been fractionated by the distillation of smaller lots of 500 g, each lot being fractionated into 11 fractions and a residue. Further work required the development of a method for separating hydroxy from nonhydroxy acids. A method has been found which gives promise of making this separation and it will be further investigated.

The great importance of oxidation in its effect on the flavors of milk and its products has warranted a continuation of the studies on some of the abstract phases of the oxidation problem as well as on the more practical aspects. It has been found that the rate of oxidation is influenced by the hydrogen-ion concentration, but that this effect is dependent upon the oxygen content of the air. At one oxygen content the effect of increasing pH may be the reverse of the effect of the same change in an atmosphere with a different oxygen content.

One posible application of the knowledge which has already been obtained from the work on oxidation is the detection of butter which is particularly suitable for storage on account of its nonsusceptibility to oxidation. Comparisons of the actual keeping quality of butter, showing when fresh varying degrees of susceptibility to oxidation, are being made.

A second application is found in studies which have been made in the past 2 years on the causes of the so-called oxidized flavor of milk. This defect of market milk is widespread, and no one theory has been offered which satisfactorily explains all of the facts that have been established. Our investigations have shown that there is a very definite relation between the oxidation-reduction potential and the factors known to influence this potential and the appearance of an oxidized flavor. The increased tendency of milk to develop the flavor at low temperatures can be explained by this hypothesis. Some milks have a greater resistance to changes in reduction potential than others and this tendency is increased when cows change from dry feed to green feed. This change is usually accompanied by a disappearance of the oxidized flavor. The growth of bacteria in the milk, heat, metallic contamination, aeration, changes in reaction, addition of oxidizing or reducing substances, all affect the oxidation-reduction potential and all are factors in determining if milk has or has not an oxidized flavor. The assumption that there is in the milk a substance which at one stage of oxidaton has the flavor but loses this flavor when more highly oxidized seems to meet all the requirements of the established facts.

Continued study of the conditions which control the germination and the destruction by physical agents of bacterial spores has brought forth some interesting and significant information of a highly technical nature; but has failed to reveal any method, except the use of very high temperatures, which will destroy the small proportion of very resistant spores found in every spore-forming culture. No growth-stimulating substance has been found which will induce partial or complete germination and thus throw these very resistant spores into a condition in which they may be destroyed at comparatively low temperatures.

The effect of various food-accessory substances on the germination of spores after they have been exposed to heat or ultraviolet light, indicates that the effect of these physical agents is not identical. The addition of a growth-promoting substance like blood serum to spores exposed to ultraviolet radiation causes a marked increase in the number of spores which germinate while the same addition to spores exposed to heat produces no effect. This indicates that heat and ultraviolet light produce their lethal effect on spores by acting on different sets of vital functions. The action of ultraviolet rays in sensitizing spores to heat is increased if the rays are passed through fluorite rather than quartz. The very low penetrating power of the short waves transmitted by fluorite preclude the use of these rays in work on milk.

Nearly 3 years ago an investigation was started to determine the effect of milk from cows affected with mastitis on the quality of Swiss cheese. It was necessary, in order to have definite information about the condition of the milk, to make routine examination of the milk of a considerable number of cows for a long period. In this way a very clear picture has been obtained of the bacteriological, chemical, and physical changes which take place in the milk before, at the onset, and during the course of the disease. These observations have established quite clearly that all the usual indications of mastitis may appear in the milk without a precipitable invasion by bacteria, and conversely, large numbers of the bacteria usually associated with mastitis may be present in the udder without causing the symptoms. This indicates that while the bacteria may actually cause the damage to the tissue which is associated with severe mastitis, a second factor in addition to infection by the bacteria must be present before a typical case of mastitis can occur. The results which we have already obtained give some indication of what this factor is, but it is unsafe to draw definite conclusions on the data now available. The nutrition herd to which our work has been confined is now free from mastitis except those cases in which it has been artificially induced. Previous to the beginning of this work the herd had been severely infected for a number of years.

BUTTER AND BYPRODUCTS

The commercial factory now making lactic acid by the method developed in these laboratories, by fermentation of the lactose of whey, has increased its operations until the capacity of the plant has been reached. This is equivalent to the utilization of between 40,000 and 50,000 pounds of whey daily. While a market has been found for all the lactic acid and its products which this plant can make, any material increase in the utilization of whey by this method must depend on new uses for the lactic acid produced.

In the past year resins have been made from lactic acid which may have some valuable applications and which at least indicate the possibilities in this field. There is also the possibility of converting lactic acid into other acids for which there is a large and increasing demand and work along this line will be pushed as actively as circumstances permit.

In the past 2 or 3 years considerable interest has been created by newspaper reports concerning a textile fiber resembling wool which is being made from casein in Italy on a commercial basis. The Italian process has not been made public, and there has been no information available to these laboratories to serve as a basis for developing a fiber of this nature. As may have been expected from the chemical differences in casein and cellulose, methods used in producing rayon from cellulose could not be applied to casein. In solving this problem it was necessary to find first some combination with casein which would produce a fiber with the required strength, elasticity, and pliability, and second a bath which would convert the liquid or semiliquid casein combination into a solid as it comes from the spinneret. A number of combinations have been found which will produce a fiber from casein, but to give proper pliability and overcome a tendency to become brittle on standing the addition of a plasticizer is necessary. A number of satisfactory plasticizers have been found. A rather wide latitude is permitted in the constituents of the bath used to dehydrate and solidify the casein as it is projected in a fine stream from the spinneret. The strength and elasticity can be further increased by a second treatment after fibers come from the dehydrating bath. It has also been found that by certain additions to the casein solution the fiber may be made water- and fire-resistant.

Up to the present time all fibers have been made with an improvised laboratory apparatus and have not been of sufficient uniformity to permit spinning or strength tests. This will be done through cooperation with one of the companies making cellulose fiber. The economic status of this project can only be determined for American conditions when extensive spinning tests have been made and yield and costs of manufacture established. We are not yet in a position to discuss this phase of the question.

A method developed last year for the extraction of lactose from concentrated whey or whey powder has been tried on a semiplant scale and some of the mechanical difficulties removed. By the use of this method about 75 percent of the sugar has been recovered although it is possible to extract the lactose completely. A residue is obtained containing 48.8 percent of nitrogenous material of which three-fourths is soluble in water. By extractions at higher temperatures a very fine, highly soluble sweet lactose was obtained.

Dairy byproducts are already suitable human food and the main objective of any program for the utilization of these products should be their conversion into more acceptable forms for human consumption. This is especially difficult with whey on account of the high dilution of its solids, the preponderance of sugar, and its lack of palatability. One of the first requirements is to convert it into a more concentrated form in which it can be transported and held in storage to even up the variable production. This may be done by drying completely, but for plants having a relatively small volume a method has been devised for concentration under vacuum with the addition of cane sugar to make a product somewhat comparable to sweetened condensed milk. If the concentration is adjusted properly the thickening due to lactose crystallization can be avoided.

The possible use of whey has now been demonstrated for four types of food products. In soups it may be used to increase the palatability and nutritive properties and to give a creamy consistency without the objectionable curdling frequently encountered when whole milk is used. It may be used with pumpkin in place of eggs to make a pie filling which can be put in cans ready for use. It may be combined with various fruits to make whips and frozen desserts. These preparations may be sterilized and kept on hand ready for use. An excellent whipping property is obtained. By whipping and mixing with whipped cream an ice-cream mix is obtained which freezes satisfactorily without stirring in mechanical refrigerators. A preserve can be made by mixing whey solids with jams, making a product which can be whipped to about 100-percent overrun. Because of its high air content it lacks the intense sweetness and richness of ordinary jam.

Whey solids may be incorporated in various types of candies. The most promising one is made by whipping concentrated sweetened whey, incorporating nuts, coconut, or other flavoring material and drying until it acquires a light crumbly texture free from sandiness. The tendency to absorb water may be overcome by coating with chocolate.

While buttermilk made by souring skimmed or partly skimmed milk with a lactic culture is an important part of the market-milk business, there are still frequent complaints that this lacks the characteristic flavor of "old-fashioned" buttermilk made by churning cream in butter making. We have found that an excellent imitation of the desirable flavor of real buttermilk may be obtained by proper manipulation of the Kefir grains coming originally from the Union of Soviet Socialist Republics and used occasionally in this country to make a special fermented milk. These peculiar cauliflowerlike grains are a mixture of two types of lactic bacteria and a lactose-fermenting torula yeast. By controlling the temperature the yeastly fermentation can be retarded and a sour milk obtained which has a flavor which many people who have tested this product find very acceptable.

The method of propagation is very simple and depends primarily on the control of temperature.

ICE CREAM

A considerable advance in the theory of ice-cream making resulted with the determination that a simple relationship exists between the temperature of an ice-cream mix in the freezer and the overrun existing at the moment, the higher overrun existing at the higher temperatures.

Experiments so far indicate that the whipping capacity of an ice-cream mix can be expressed by a straight-line equation of the form percent overrun $= aT + b$ where T is the temperature in the freezer and a and b are constants, subject to the qualification that each mix as it approaches complete melting reaches a maximum possible overrun for that mix, and also possibly to a further limiting figure, capable as yet of but approximate evaluation, which may describe the stability of the whip to continued beating in the freezer. The equation then, plus a statement of maximum overrun and stability will describe the whipping properties of each mix. It is believed that this is true of all ice-cream mixes of usual composition and treatment.

Progress is being made in determining the relationship of various factors of ice-cream manufacture to overrun. Some factors influence whipping by actually altering the temperature-overrun equilibrium of the mix; others, of which aging is apparently one, simply affect the mix stability.

CHEESE

Progress has been made in the control of the composition of Swiss cheese with special reference to moisture and fat. Notwithstanding the fundamental nature of these two factors, no definite information has been available on methods of control or the optimum requirements for the best quality of cheese. Methods have been established for the control of water content within a range sufficiently wide for experimental purposes. This will make it possible to determine the water content that will produce the best physical properties and following this to establish the effect of varying fat content on the quality of the cheese and possibly the optimum percentage to obtain uniformly a satisfactory texture. For the cheese maker to use this information properly, it will be necessary to devise methods by which he can quickly determine the adjustments necessary to obtain the required amount of fat in the finished cheese. A formula has been established by which the required standardization can be calculated with a fair degree of accuracy but additional investigation will be necessary before it can be used in the factory.

The temperature relations and other factors, which influence the activity of the various cultures that have been collected for use as Swiss-cheese starters, have been determined; thus making it possible for the fieldmen to use the different cultures more intelligently. The information that has accumulated in these laboratories on the use of cultures, examination of the milk and on Swiss-cheese making in general, has been put in a form in which it is now readily available to fieldmen.

In developing the commercial use of canned cheese certain difficulties have been encountered, some of which can be corrected by the application of well-known principles while others require research work to clear up obscure questions of manufacture and curing. Many manufacturers are inclined to make a cheese with high moisture and acidity and to hold it at a low temperature in order to check its tendency to develop an acid body and bitter flavor. This results in a cheese lacking the desirable flavor which is obtained when moisture, acidity, and curing-room temperature are properly regulated. The general principles governing these conditions are known, but there is a lack of definite information which can be cited to establish the limitations within which a good flavored cheese may be expected. In the past year a large number of vats of Cheddar cheese have been made with all of the manufacturing conditions, including moisture content and acidity, at various stages of making and ripening known and recorded, and this cheese has been ripened at four different temperatures. The results have not yet been completely tabulated but they promise to yield some definite information of interest to cheese manufacturers who are interested in making a cheese of high quality.

One of the defects of Cheddar cheese which is especially evident in the canned cheese is the tendency to leak fat and become greasy when for any reason it is exposed to relatively high temperatures. Homogenization of the milk to overcome this difficulty has been attempted, but the peculiar flavor given to the cheese by this process has heretofore prevented its use. However, a modification of the usual method of homogenizing cheese milk has been devised which makes it possible to make a normal cheese that will not leak fat under any ordinary conditions. This has also made it possible to make a cheese of the Cheddar type but with a high fat content and certain characteristics which distinguish it from other cheeses. This has not yet been completely developed, but it has sufficient promise to warrant further experimentation.

It has been found that cow's-milk Roquefort cheese can be cured at temperatures as low as 42° and as high as 60° F., although at the high temperature the mold development was frequently unsatisfactory. Everything considered, better results were obtained at 48° than at the other two temperatures.

Roquefort cheese made from the milk of cows on dry feed has a white curd characteristic of the sheep's-milk cheese, but when the cows are on green feed a distinctly yellow curd is likely to predominate. Some improvement in color may be obtained by the use of a small amount of chlorophyl, which has some reducing action on the yellow pigment.

ESTABLISHING NEW METHODS AND PRODUCTS

In the work with the Swiss cheese factories in Ohio and Wisconsin, the automobile laboratories have been in use for over a year and have given very satisfactory service. A limited number of the smaller factories have intermittent laboratory service through which they obtain definite information about the bacteriological condition of their milk supply, the condition of their starter cultures, the composition of the milk before and after standardization, the composition of the cheese, and other data, which enables them to control their manufacturing and curing processes in a more intelligent manner than has previously been possible. At the same time, a mass of data is accumulating which will undoubtedly throw light on many of the troubles which cheese makers encounter in making this type of cheese.

There is now an opportunity for a similar service for the Cheddar cheese industry, with promise of greater and more prompt returns in improvement of the cheese and recognition of the value of the work. The results obtained in our own investigation supplemented by those obtained elsewhere indicate that by controlling within reasonable limits three points in the manufacturing process a uniform product of good quality can be obtained. This control requires laboratory methods which few factories are in a position to furnish, but which could easily be provided if their value were demonstrated.

Considering the great volume of Cheddar cheese in relation to other varieties, the potential value of this work is evident.

The use of the valve-vented can continued to show a slow but steady increase. One company using a 5-pound can holding 10 8-ounce prints has increased its pack this season to 500,000 pounds by concentrating at a central packing point the make of 10 or 12 factories for the greater part of the season. The sale of the 12-ounce cans made by a Pacific coast cooperative is increasing slowly and some sale has been developed in Alaska for the 5-pound can. Including the various styles and sizes about 675,000 pounds will be packed in cans this year.

A significant incident at one of the cooperative factories shows the consumer appreciation of this package. This factory was making for its patrons a special paraffined loaf for which there was a ready sale. When the 5-pound can was offered to the same trade, but at a higher price, the canned cheese completely displaced the loaf.

The small commercial cheese factory established as noted in last year's report is making a very good quality of Roquefort-type cheese and developing a market for its product in spite of the competition of the low-priced imported blue-vein cheese. It is very evident, however, that enterprises of this nature should not be attempted where competition or regulation forces the price of milk much above the limits usually applying to milk for cheese making.

The factory making lactic acid by the fermentation of whey has had a prosperous year and has increased its output to the capacity of the plant. This, however, is a method of utilizing whey requiring for its successful operation a large volume of whey, a very considerable investment for equipment, and technical skill in chemical processes.

The cooperative work with creameries, cheese factories, and milk plants in Tennessee has resulted in a decided improvement this year in the quality of cream delivered to the creameries in that section. Insanitary and improperly operated cream stations have been closed or put in proper condition, and an effective system of grading has been put in force. This has been accomplished through the cooperation of State and Federal officials and the creamery operators. The successful efforts to improve the cream delivered to Tennessee creameries on which our representative has been engaged for several years is reflected in the gradual improvement of the butter which now compares favorably with that from many of the older dairy States.

DIVISION OF MARKET-MILK INVESTIGATIONS

ERNEST KELLY, *in charge*

The specialists of this Division, in addition to carrying on various research projects, have given considerable time in an advisory capacity to other offices of the Department as well as to other branches of the Government where the work is related to market-milk problems.

DAIRY SANITATION INVESTIGATIONS

TESTS FOR MASTITIS

Studies were begun during the year to determine the reliability of certain tests for bovine mastitis. Analyses have been made on more than 1,400 samples of milk aseptically drawn from individual quarters of the udder. Ten heifers with normal, healthy udders and eight cows that had each lost one quarter from previous mastitis infection were used. The animals were in various stages of lactation when the study was started and none has gone through an entire lactation period during the study. The observations to date do not permit definite conclusions, but they indicate certain trends.

The data were arranged for study in relation to the stage of lactation, being grouped by 60-day periods. Care was taken to eliminate all milk samples where any organisms other than *Streptococcus agalactiae* seemed to be infecting the udder. From this analysis, there appears to be a fairly regular increase in the chloride content of the milk as the lactation period advances—an average of 0.1132 percent during the first 60 days after calving to an average of 0.1570 percent after a lactation period of 360 days or more. There seems to be a trend also toward an increase in the number of leucocytes as lactation advances. There is no regularity in the frequency with which streptococci are found in the various stages of lactation.

This would indicate that high chloride content and leucocytosis in milk are not always a true indication of udder infection. This was particularly noticeable with cow no. 1235. In a total of 16 quarter samples from that animal no organisms that would probably cause an infection were ever found; however, the average chloride content for all quarter samples was 0.237 percent and the average leucocyte count was 1,592,000 per cubic centimeter. The milk always coagulated slowly or not at all with rennet. The animal never exhibited clinical symptoms of mastitis. Similar observations have recently been reported by Hastings and Beach (Jour. Agr. Research 54: 199–220, 1937) in their work with a herd apparently free from mastitis infections.

A considerable lack of agreement was found between the various tests used to determine the abnormality of the milk. Criteria used to indicate abnormal milk were as follows: Chlorides, 0.140 percent or more; leucocytes, 500,000 per cubic centimeter or more; and the presence of streptococci as shown by either the Hotis test or the plate count. The Hotis test detected streptococci in 43 samples that were negative on the blood-agar plates, while in only 3 instances were streptococci found on the plates when the Hotis test was negative.

Table 6 shows the comparative results when the three criteria were applied to 331 samples of milk, each of which was abnormal by at least one criterion:

TABLE 6.—*Results of applying 3 criteria of abnormality to 331 samples of milk*

Items compared	Abnormal samples	
	Number	*Percent*
Criteria of abnormality:		
Presence of streptococci	144	44
0.140 percent of chlorides or more	157	47
500,000 leucocytes or more per cubic centimeter	152	46
Abnormality indicated by—		
At least 1 criterion	331	100
At least 2 criteria	148	45
All 3 criteria	65	20

No one criterion indicated abnormality in as many as half of the samples. The explanation indicated is that although most infections causing clinical symptoms of mastitis in the cow are accompanied by high chloride content and leucocytosis in the milk, there are many instances where transient or permanent increases in chloride content or leucocyte count may occur without any apparent infection.

It was found that when a quarter began shedding streptococci after a period in which no streptococci were found, there was usually a corresponding rise in chlorides and leucocytes. Frequently in such cases the rise was not sufficient to cause the quarter to be classified as "mastitis" by the fixed standards employed; but these criteria seem significant, nevertheless, in view of the previous records of that quarter. An abrupt change, though small, accompanying the first appearance of streptococci, may be found more significant than any arbitrarily fixed standard for determining when a cow has mastitis. It is hoped that future work covering several lactation periods for each cow under study will aid in clarifying the points suggested in this early work.

During a recent outbreak of acute mastitis in the Beltsville dairy herd, samples from some of the affected cows were examined in our laboratory. From most of the affected quarters was isolated an organism belonging to the genus *Pseudomonas*. Isolations were made from each of 10 cows. The organisms were found in almost pure culture. Because of the infrequence of occurrence of *Pseudomonas* species in mastitis a detailed study is being made in cooperation with the Bureau of Animal Industry to identify the organism as to species and to determine its relationship to the udder infections.

SCORE CARDS

The score cards for the sanitary inspection of dairy farms and for the sanitary inspection of city milk plants have been completely revised and brought up to date. They were unanimously approved by the American Dairy Science Association at the annual meeting in June 1937.

MILK-PLANT MANAGEMENT STUDIES

MILK-BOTTLE LOSSES

Studies of milk-bottle losses undertaken a few years ago were completed during the year and the results were prepared for publication. The studies included a survey of the life of the bottle at 111 milk plants and a comparison of the efficiency of the various systems used at these plants to increase the number of trips per bottle.

Reports from the 111 milk plants indicate that the life of the bottle at these plants was as follows: Average, 34.58 trips; range, 6 to 91 trips; median, 29 trips; mode or most common, 28 trips. More than 36 percent of the dealers reported a life of between 20 and 30 trips.

Ten plants which did not belong to a bottle exchange reported an average life of 22.58 trips, while 78 plants belonging to bottle exchanges reported an average life of 30.24 trips. The longest life for the bottle was obtained at plants which pooled the bottles or charged them to the drivers, an average of 47.32 trips being reported at 6 plants using the former system and of 51.13 trips at 17 plants using the latter system.

Thirty-two plants which charged stores for all bottles delivered to them reported an average life of 41.30 trips, while 46 plants which did not charge stores reported an average of only 22.55 trips. Twenty plants which paid the drivers a commission based on the return of bottles reported an average of 43.07 trips per bottle, while 58 plants which had no such commission system reported an average of only 25.82 trips. These two latter systems, together with the operation of a milk-bottle exchange, are the most important factors in increasing the life of the bottle according to our data.

A survey was made by means of a questionnaire of 67 bottle exchanges owned and operated by milk dealers and 19 privately operated exchanges. Tabulations were made as follows: (1) Relation of whether or not the bottles were washed by the exchange to the number of plant employees required and bottles handled per man. (2) Investments in plants and equipment by exchanges handling varying quantities of bottles. (3) Relation of number of bottles handled by exchanges to operating costs per bottle. (4) Effect of washing the bottles and of trucking the bottles by the exchange on operating costs. (5) Prices charged and paid by exchanges per bottle and spreads taken by exchanges.

Of a total of 70 exchanges, 52 reported a small profit. Twenty-four of these exchanges reported that some of their funds were used in advertising campaigns to increase the consumption of milk.

Forty-six exchanges reported that dealers charged stores for bottles and the prices charged varied from 1 cent to 6 cents per bottle, but the most common price charged was 5 cents per bottle. Fourteen exchanges reported that a universal store bottle was used in their cities.

Thirty-two exchanges reported that special bottles were required for fruit juices, and 42 reported that no special bottles were required. Sixty-eight exchanges reported that no special bottle was required for chocolate drink and six reported that a special bottle was required in their cities.

CREAM LINE ON RAW MILK

Thirteen tests were made at Beltsville to determine at what temperature of cooling immediately after milking the best cream line can be obtained on raw milk. The tests indicate so far that a better cream line is obtained on milk cooled to 50°–60° F. than on milk cooled to a lower temperature. The milk cooled to 50°–60° also showed a better cream line when recreamed after 24 hours than milk cooled to a lower temperature. Some dairies let the milk set overnight after it is cooled and bottle it the next day and have had trouble with the cream line. These tests so far indicate that such dairies would get better results if they cooled only to 50° or 60° before placing the milk in the refrigerator.

Better cream-line results were obtained both on fresh milk and on milk recreamed after 24 hours when stored at 35° F. than when stored at 48°.

Only a few tests have been made so far and it is possible that the technique used may be changed; it is therefore impossible to draw definite conclusions until further tests have been made.

CREAM PLUG ON BOTTLED CREAM

Two tests were made on the effect of cooling cream in the vat after pasteurization on cream-plug formation. These tests were only preliminary but showed that while no cream plug resulted on cream cooled to 110° F. in the vat and then cooled to 45° without agitation, a cream plug did form on cream which was cooled to 45° in the vat.

A device has been installed on the pasteurizing vat at Beltsville which will permit varying speeds on the coil, and tests will be made on the effect of using high and low coil speeds.

MILK-QUALITY IMPROVEMENT INVESTIGATIONS

Two phases of the work on chlorine solutions, described in last year's report, have been partially completed during the year. Owing to the pressure of other and more important work the completion of these projects will have to be deferred until some time later.

STABILITY OF CHLORINE SOLUTIONS

Three chlorine solutions (a chloramin, a hypochlorite, and a buffered hypochlorite) containing about 200 parts per million of available chlorine were used in an experiment to test the stability of the solutions when kept in open or closed containers. Each solution was divided into two equal parts and put into 4-liter Erlenmeyer flasks, one of which was left open and the other tightly stoppered. Every 2 days each solution was tested for available chlorine. At the end of 10 days the chloramin in the open container reached a constant concentration which it held for 2 weeks, at which time the concentration gradually increased about 6 p. p. m. in the ensuing week. All of the other solutions gradually lost strength. The final or total percentage of available chlorine lost was as follows: (1) In the open flasks—chloramin, 4.23 percent; buffered hypochlorite, 36.06 percent; hypochlorite, 46.21 percent. (2) In the closed containers—chloramin, 8.92 percent; buffered hypochlorite, 13.94 percent; hypochlorite, 24.06 percent.

Another study was made on the stability of chlorine solutions, using sodium hypochlorite, buffered sodium hypochlorite, and chloramin-T, containing about 200 p. p. m. of available chlorine. The results of this study are summarized below:

In closed containers at room temperature, sodium hypochlorite and buffered sodium hypochlorite lost available chlorine at a uniform rate over a period of 3 weeks. About 10 percent of the available chlorine was lost in this time.

The strength remained fairly constant during the fourth week and then deteriorated rapidly. About 25 percent of the available chlorine was lost at the end of 5 weeks. Chloramin-T solutions, under the same conditions, lost strength slowly. About 7 percent of available chlorine was lost in 5 weeks, of which 4 percent was lost during the last week.

In open containers at room temperature, the available chlorine in sodium hypochlorite and buffered sodium hypochlorite increased at a uniform rate for the 3 weeks, an increase of 17 percent being noted in this time. After this the strength increased very rapidly for the remaining 4 or 5 days. The chloramin-T solution increased in strength at a greater rate than the other two solutions. After 3 weeks the available chlorine was 45 percent greater than at the beginning. After this the strength increased very rapidly for the remaining 4 or 5 days, the final concentration being over three times as great as in the beginning.

In closed containers in a refrigerator, all solutions remained very constant in strength, losing 2 percent or less of the available chlorine in 5 weeks.

A test was also made to determine the effect of temperature on the available chlorine content of a buffered hypochlorite solution. A solution of known strength was heated to 82°–84° C. and held within that temperature range for 10 minutes, then cooled to 22°. The strength of the solution was found to be the same after it had cooled as before it was heated.

DISSIPATION OF AVAILABLE CHLORINE BY MILK

To determine the efficiency of chlorine solutions under conditions where the dairy utensils are carelessly washed before the solution is applied, tests were made to show the dissipation of chlorine by adding milk to the solution. The solutions used contained 200 p. p. m. of available chlorine and the milk was added at a temperature of 25° C. The results are summarized as follows: (1) Dissipation of chlorine was very rapid until saturation, followed by a very slow loss. Most of the dissipation occurred within 2 minutes; (2) amount of dissipation depends upon the amount of milk present; (3) about 30 percent of milk was required to dissipate all the available chlorine of chloramin-T within 2 minutes; (4) about 55 percent of milk was required to dissipate all the available chlorine of sodium hypochlorite and buffered sodium hypochlorite within 2 minutes; (5) small amounts of milk (1 or 2 percent) reduced the available chlorine of chloramin-T to a less extent than in the case of sodium hypochlorite or buffered sodium hypochlorite.

SOUR CREAM

In January 1937, a study of methods for developing sour cream in the home was started. The object was to find the best method for home production of thick sour cream such as is used in salad dressings, etc.

To keep down the cost it was decided to use coffee cream as the base. This cream will usually have about 20 percent of butterfat. Varying amounts of commercial buttermilk were added to the sweet cream as a starter or culture. The cream was then incubated for varying lengths of time at different temperatures. At the start both raw and pasteurized cream were used, but after a number of trials the work was restricted to pasteurized cream alone. In all, 47 samples of cream were inoculated and incubated and then tested for acidity, time to whip, and viscosity. The sour cream and then the whipped cream were tested for tension on the curdometer.

The experiments demonstrated that a sour cream of good flavor, reasonably heavy body, and good whipping quality could be made by the following procedure: Inoculate a pint of good-quality pasteurized coffee cream with 5 teaspoonsful of fine-flavored commercial buttermilk. Incubate at from 75° to 85° F. for 24 hours, then hold it cold in a refrigerator for not less than 24 hours more. Specialists in the Bureau of Home Economics used some of this cream and were well pleased with the results.

CURD TENSION OF MILK AND ITS RELATION TO DIGESTIBILITY

EFFECT OF DIFFERENT COAGULANTS

Work has been continued on the study of the relation of the curd tension of milk to its digestibility.

In preparing to measure the curd tension, three different coagulants have been used to coagulate the milk—the Hill coagulant, hydrochloric acid-pepsin,

and an artificial gastric juice prepared from hog-stomach linings. The curd-tension readings were found to vary considerably, according to the coagulant used. On the average, the hydrochloric acid-pepsin coagulant gave a curd-tension reading 30.4 percent lower than the Hill coagulant; the artificial gastric juice gave a reading 38.0 percent lower than the Hill coagulant and 11.4 percent lower than the hydrochloric-acid pepsin.

For comparative purposes any one of these three coagulants would be satisfactory were it not for the fact that the same variations do not hold true with both hard-curd and soft-curd milks.

With hard-curd milks, the average curd-tension reading was 109.1 g when the Hill coagulant was used; 90.5 g when the hydrochloric acid-pepsin was used; and 79.5 g when the artificial gastric juice was used. With soft-curd milks, the average curd-tension readings were 37.0, 11.2, and 10.6 g respectively, for the three coagulants.

These results indicate that, for both hard-curd and soft-curd milks, the curd-tension readings obtained with the hydrochloric acid-pepsin and gastric juice agree closer with each other than with the readings by the Hill method. Although the hydrochloric acid-pepsin and the artificial gastric juice gave fairly comparable readings, the former appears to be the more satisfactory because of the difficulty to prepare the artificial gastric juice.

ADDING MILK TO COAGULANT VERSUS ADDING COAGULANT TO MILK

Different curd-tension readings have been obtained with the same milk when the only change in procedure was to add the milk to the coagulant instead of adding the coagulant to the milk. This holds true regardless of whether the Hill reagent, hydrochloric acid-pepsin or artificial gastric juice is used as the coagulant.

With the exception of where artificial gastric juice was used with a relatively hard-curd milk, adding the milk to the coagulant gave a lower curd tension than adding the coagulant to the milk. The various coagulants reacted differently on hard- and soft-curd milks. When the Hill coagulant was used the greatest variation took place with hard-curd milk, whereas with the hydrochloric acid-pepsin and artificial gastric juice the greater variations were with soft-curd milk.

It is impossible to determine which of these two procedures is the correct one to use in measuring curd tension. However, the fact that less variation occurs in the curd-tension readings of duplicate samples when the milk is added to the coagulant indicates that this is the preferred method.

DIGESTION IN RELATION TO CURD TENSION

For the digestion trials the samples were divided equally according to curd tension, the so-called hard-curd samples in one group and the soft-curd samples in the other group. Artificial gastric juice was used as a digestant and the amount of digestion was determined by titrating with N/10 alcoholic potassium hydroxide, using O-cresol-phthalein as an indicator.

The results indicate that soft-curd milk is not only more rapidly digested than hard-curd milk, but that it is also more completely digested. The increase in digestion of the soft-curd milk over the hard-curd milk was 21.6 percent during the first hour, 7.6 percent at the end of 2 hours, and 16.8 percent at the end of 4 hours (table 7). However, when the digestion measurements are plotted against the curd-tension readings there appears to be no relation between the curd tension and digestibility of the milk. This holds true regardless of which one of the three coagulants is used. The formal titration method of measuring digestion is now being used to check the results obtained with the alcoholic potassium hydroxide titration.

TABLE 7.—*Average digestion of the hard- and soft-curd milks*

Character of curd	Determinations	Digestion in—		
		1 hour	2 hours	4 hours
	Number	*Cc*	*Cc*	*Cc*
Hard	20	0.97	1.58	2.02
Soft	20	1.18	1.70	2.36

EDITORIAL AND INFORMATION WORK

L. S. RICHARDSON, *in charge*

Eight publications were printed in the Department series, six of which were new and two were revisions of existing publications. At the end of the year seven manuscripts were being prepared for publication. Twenty-two publications were reprinted one or more times during the year and 13 manuscripts prepared in other bureaus were reviewed. Forty articles written by members of the Bureau were published in dairy and agricultural journals outside the Department, and 18 publications were issued in mimeograph form for use in carrying on the Bureau's educational and service activities. Assistance was given the Radio Service in the preparation and delivery of 54 broadcasts, and 17 news releases were prepared for distribution to the press through the Department's Press Service. This Office also cooperated with the Extension Service in the preparation and revision of a number of film strips on dairy subjects, and with the Office of Exhibits in the preparation of and revision of dairy exhibits for the National Dairy Show at St. Louis, and at the State fairs. A special exhibit dealing with the Bureau's work in the utilization of byproducts was prepared for the Dairy Industries' Exposition at Atlantic City.

PUBLICATIONS

The following articles and Department publications written by workers in the Bureau were issued during the fiscal year:

FEEDS AND NUTRITION

Toxic effect of cod liver oil in the ration of the rabbit and the calf. W. A. Turner, E. B. Meigs and H. T. Converse. U. S. Bur. Dairy Indus. BDIM–721. [Mimeographed.]

Rate of decomposition of carotene in hays during storage at different seasons of the year. Abstract. H. G. Wiseman, E. A. Kane, and C. A. Cary. Jour. Dairy Sci. 19: 466–467.

Effect of moisture content and density of stored roughage on temperatures attained during storage and the quality of the product. Abstract. J. B. Shepherd, T. E. Woodward, and R. R. Graves. Jour. Dairy Sci. 19: 467–468.

The effect of certain factors upon the color and pigments of alfalfa hay in storage. Abstract. T. E. Woodward. Jour. Dairy Sci. 19: 468–469.

An experiment in chopping alfalfa hay at the time of storage. Effect upon space required, temperatures attained, color, feeding value, and losses of feed constituents. T. E. Woodward and J. B. Shepherd. Jour. Dairy Sci. 19: 697–706.

Spectrophotometric data bearing on the character of the pigments obtained in routine determinations of carotene in hays, silages, and freshly cut plant materials. Abstract. E. A. Kane, H. G. Wiseman, A. M. Hartman, and C. A. Cary. Jour. Dairy Sci. 19: 466.

Vitamin A replaces whole milk in the calf ration. H. T. Converse and E. B. Meigs. U. S. Bur. Dairy Indus. BDIM–731. [Mimeographed.]

The vitamin A requirements of dairy cows for reproduction and lactation under practical conditions. Abstract. E. B. Meigs and H. T. Converse. Jour. Dairy Sci. 19: 438.

The accuracy of routine carotene determinations as a measure of vitamin A potency. Abstract. L. A. Shinn, E. A. Kane, H. G. Wiseman, and C. A. Cary. Jour. Biol. Chem. 119 (1): lxxxix–xc.

The color, carotene, and vitamin A content of milk as influenced by the feed. R. E. Hodgson. Wash. State Col. Inst. Dairying Proc. Ann. Meeting 1936: 133–136. [Multigraphed.] (With Wash. Agr. Expt. Sta.)

The method of single feeding as used in measuring the vitamin A activity of pasture grass artificially dehydrated at different temperatures. R. E. Hodgson and J. C. Knott. West. Div. Amer. Dairy Sci. Assoc. Proc. Ann. Meeting 1936: 41–46. [Mimeographed.] (With Wash. Agr. Expt. Sta.)

Pea feed and other pea by-products for dairy cows. J. C. Knott, R. E. Hodgson, and O. J. Hill. Wash. State Col. Ext. Bull. 214. (In cooperation.)

The composition and apparent digestibility of the flat pea (*Lathyrus silvestrus wagneri*). R. E. Hodgson and J. C. Knott. Jour. Dairy Sci. 19: 531–534. (With Wash. Agr. Expt. Sta.)

The composition and apparent digestibility of pea-cannery refuse. J. C. Knott and R. E. Hodgson. West. Div. Amer. Dairy Sci. Assoc. Proc. Ann. Meeting 1936: 49–51. [Mimeographed.] (With Wash. Agr. Expt. Sta.)

Apple pomace for dairy cows. J. C. Knott, R. E. Hodgson, and O. J. Hill. Wash. State Col. Ext. Bull. 217. (In cooperation.)

The determination of the apparent digestibility of green and cured grass by modified procedures. J. C. Knott, H. K. Murer, and R. E. Hodgson. Jour. Agr. Research 53: 553–556. (With Wash. Agr. Expt. Sta.)

The production of Jersey cows on roughage rations. J. A. Simms. Abs. Papers Ann. Meeting South. Div. Amer. Dairy Sci. Assoc. in conjunction with Ann. Conv. Assoc. South. Agr. Workers 1937: 15. [Mimeographed.]

Milk and butterfat yields of Holstein cows on rations restricted to roughage. Abstract. J. R. Dawson and R. R. Graves. Jour. Dairy Sci. 19: 464–465.

The losses of dry matter in corn silage stored in snow-fence silos and the cost per ton of storage. Abstract. J. B. Shepherd. U. S. Bur. Dairy Indus. BDIM–769. [Mimeographed.]

Methods of making grass silage. Abstract. T. E. Woodward. Jour. Dairy Sci. 19: 460.

A comparison of the Hohenheim system with ordinary methods of pasture management. T. E. Woodward and M. A. Hein. Assoc. South. Agr. Workers Abs. Papers Ann. Conv. 1936–1937: 17–18. [Multigraphed.] (With Bur. Plant Indus.)

Our million alfalfa acres. O. E. Reed. Mich. Farmer 187 (4): 57, 71.

Pasture studies. E. W. Faires. S. C. Agr. Expt. Sta. Ann. Rept. 1936: 125–126. (In cooperation.)

Hatch farm records. C. W. McIntyre. Mo. Agr. Expt. Sta. Bull. 370 (Ann. Rept. 1935): 50. (In cooperation.)

BREEDING

Superior germ plasm in dairy herds. R. R. Graves and M. H. Fohrman. U. S. Dept. Agr. Yearbook 1936: 997–1141.

Evaluating inheritance for type from grades recorded in the germ plasm survey. Abstract. W. W. Swett. Jour. Dairy Sci. 19: 431.

Some additional findings of the dairy cattle germ plasm survey. Abstract. M. H. Fohrman. Jour. Dairy Sci. 19: 431–432.

The technic of artificial insemination with dairy cattle. F. W. Miller. U. S. Bur. Dairy Indus. BDIM–738. [Mimeographed.]

The assay of the lactogenic hormone. Abstract. E. I. Evans. Amer. Jour. Physiol. 119: 304.

Bio-assay of male hormone by gross weight of seminal vesicles and prostate gland from immature castrate rats. Abstract. S. R. Hall (introduced by E. I. Evans). Amer. Jour. Physiol. 119: 324–325.

Male hormone in the urine of bulls and rams. Abstract. L. W. Butz and S. R. Hall. Jour. Biol. Chem. 110 (1): xvi. (With Bur. Anim. Indus.)

Nonvenereal transmission of *Trichomonas foetus* infection in cattle. J. Andrews and F. W. Miller. Amer. Jour. Hyg. 24: 433–438. (With Johns Hopkins Univ.)

Establishing a strain of cattle pure for high production by means of selection and continued use of proved sires. A. C. Ragsdale and C. W. McIntyre. Mo. Agr. Expt. Sta. Bull. 370 (Ann. Rept. 1935): 49. (In cooperation.)

HERD MANAGEMENT AND IMPROVEMENT

Incomplete milking in relation to milk production and udder troubles in dairy cows. T. E. Woodward, R. P. Hotis, and R. R. Graves. U. S. Dept. Agr. Tech. Bull. 522.

Dairy cattle judging. A. B. Nystrom. U. S. Dept. Agr. Farmers' Bull. 1769.

The future dairy herd improvement association sire program. Abstract. E. E. Heizer and J. F. Kendrick. Jour. Dairy Sci. 19: 518–519. (With Ohio Agr. Expt. Sta.)

Recording the identity and production performance of all animals in dairy-herd-improvement associations. J. F. Kendrick. U. S. Bur. Dairy Indus. BDIM–720. [Mimeographed.]

DHIA proved-sire list. vol. 2. J. F. Kendrick. U. S. Bur. Dairy Indus. BDIM–734. [Mimeographed.]

New phases in the DHIA and bull association programs. J. F. Kendrick. U. S. Bur. Dairy Indus. BDIM–757. [Mimeographed.]

The dairy farm-record project. [J. B. Bain.] U. S. Bur. Dairy Indus. BDIM–722. [Mimeographed.]

List of sires proved in dairy herd improvement associations, 1935–37, arranged by breeds. U. S. Dept. Agr. Misc. Pub. 277.

MILK AND CREAM

Control of the oxidized flavor in milk. G. R. Greenbank. Internatl. Assoc. Milk Dealers, Lab. Sec. Proc. Ann. Conv. 1936: 101–116.

The resazurin test for the sanitary condition of milk. G. A. Ramsdell. N. Y. State Assoc. Dairy and Milk Insp. Papers and Proc. Ann. Conf. 1936: 57–64, 66–68.

Resazurin in grading milk. G. A. Ramsdell. Hoard's Dairyman 82: 217.

Problems of the fluid milk industry. L. A. Rogers. Wash. State Col. Inst. Dairying Proc. Ann. Meeting 1936: 120–129. [Multigraphed.]

Report of collaborator on cooperative work with proposed changes in medium and temperature of incubation. E. Kelly. Internatl. Assoc. Milk Dealers, Lab. Sec., Proc. Ann. Conv. 1936: 50–74.

Country milk-receiving and cooling stations. C. E. Clement. U. S. Dept. Agr. Cir. 432.

CHEMISTRY AND BACTERIOLOGY

The phospholipids in milk. IV. Their chemical nature and their distribution among some milk products. G. E. Holm, P. A. Wright, and E. F. Deysher. Jour. Dairy Sci. 19: 631–639.

Solubility and fractionation of acid-precipitated casein using salts of certain organic acids. S. P. Gould. New York City. Thesis—Columbia University.

The function of the laboratory in the dairy industry. L. A. Rogers. Wash. State Col. Inst. Dairying Proc. Ann. Meeting 1936: 71–79. [Multigraphed.]

Comments on possible influence of variations in laboratory technique. J. F. Cone. Internatl. Assoc. Milk Dealers, Lab. Sec., Proc. Ann. Conv. 1936: 75–81.

The collection of micro-organisms above 36,000 feet. L. A. Rogers and F. C. Meier. Natl. Geog. Soc. Stratosphere Ser. 2: 146–151. (With Div. Coop. Ext.)

The significance of bacterial and chemical changes occurring in mastitis milk. Preliminary remarks and abstract. L. A. Burkey, E. B. Meigs, G. P. Sanders, and J. F. Cone. Internatl. Assoc. Milk Dealers, Prod. Sec. Proc. Ann. Conv. 1936: 67–70.

A simple method for detecting mastitis streptococci in milk. R. P. Hotis and W. T. Miller. U. S. Dept. Agr. Cir. 400. (With Bur. Anim. Indus.)

BUTTER, CHEESE, AND ICE CREAM

Regulatory problems relating to the manufacture of butter. C. S. Trimble. U. S. Bur. Dairy Indus. BDIM–739. [Mimeographed.]

Problems of the cheese industry. L. A. Rogers. Wash. State Col. Inst. Dairying Proc. Ann. Meeting 1936: 4–12. [Multigraphed.]

A new type of quinhydrone electrode for directly determining the hydrogen-ion concentration of cheese and other materials. Abstract. G. P. Sanders and E. O. Whittier. Jour. Dairy Sci. 19: 478–479.

The bacteriology of Swiss cheese. V. The use of *Streptococcus thermophilus* in ripening milk for Swiss cheese. W. C. Frazier, H. F. Long, and W. T. Johnson, Jr. Jour. Dairy Sci. 19: 535–539.

[Cheese] from a coal mine. L. A. Rogers. Food Indus. 9: 312–313.

The relationship between temperature and overrun in the whipping of ice cream mixes. A. Leighton and A. Leviton. Jour. Dairy Sci. 20: 371–378.

BYPRODUCTS

The dairy by-products problem. L. A. Rogers. Wash. State Col. Inst. Dairying Proc. Ann. Meeting 1936: 47–53. [Multigraphed.]

The utilization of whey in the preparation of some new food products. Abstract. B. H. Webb and G. A. Ramsdell. Jour. Dairy Sci. 19: 502–503.

Extent of production of casein of different types and of casein whey in the United States. R. W. Bell. U. S. Bur. Dairy Indus. BDIM–747. [Mimeographed.]

MISCELLANEOUS

Report of the Chief of the Bureau of Dairy Industry for the fiscal year ended June 30, 1936. O. E. Reed. U. S. Bur. Dairy Indus.

Activities of the Bureau of Dairy Industry. W. E. Wintermeyer. Abs. Papers Ann. Meeting South Div. Amer. Dairy Sci. Assoc. in conjunction with Ann. Conv. Assoc. South. Agr. Workers 1937: 21. [Mimeographed.]

The dairy industry. E. O. Whittier. *In* National Resources Committee, Technological Trends and National Policy, pp. 136–139. U. S. Govt. Print. Off.

The dairy industry. L. S. Richardson. Amer. Yearbook 1936: 432–434.

Cleaning dairy equipment with trisodium phosphate. L. A. Rogers and F. R. Evans. Jour. Dairy Sci. 19: 733–738.

Some observations on chlorine and metals. F. M. Grant. Ann. Rept. Internatl. Assoc. Milk Sanit. 1936: 9–14.

The toxicity of calciferol for rabbits. Abstract. A. M. Hartman. Jour. Biol. Chem. 119 (1): xlvi.

Sandhill Experiment Station. J. A. Riley. S. C. Agr. Expt. Sta. Ann. Rept. 1936: 100–126. (In cooperation.)

List of publications of the Division of Dairy Research Laboratories, Bureau of Dairy Industry, July 1904 to June 1936. U. S. Bur. Dairy Indus. Dairy Library List 7. [Mimeographed.]

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D.C. - - - - - - Price 10 cents

REPORT OF THE CHIEF OF THE OFFICE OF EXPERIMENT STATIONS, 1937

United States Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., September 15, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I transmit herewith a report of the Office of Experiment Stations for the fiscal year ended June 30, 1937.

Sincerely yours,

James T. Jardine, *Chief.*

CONTENTS

INTRODUCTION

Administrative functions and responsibilities of the Office of Experiment Stations during the year were much the same in kind as in the previous year, but were considerably enlarged and extended by administration of additional research funds made available both to the stations and the Department through the Bankhead-Jones Act of June 29, 1935 (49 Stat. pp. 436–439).

FUNDS AVAILABLE TO THE STATE EXPERIMENT STATIONS

FEDERAL-GRANT FUNDS

During the year ended June 30, 1937, Federal grants to the States, Alaska, Hawaii, and Puerto Rico for agricultural research amounted to $5,620,000 as compared with $4,995,000 for the previous year.

Under the Hatch, Adams, and Purnell Acts each State received $90,000; Alaska, $15,000; Hawaii, $50,000; and Puerto Rico, $35,000. The $1,200,000 provided for the States under the Bankhead-Jones Act was allotted on the basis of their respective rural populations, as specified by the act.

FUNDS FROM STATE SOURCES

Unlike the earlier acts authorizing Federal funds in support of State experiment stations, the Bankhead-Jones Act conditions the Federal appropriation upon each State making available from other than Federal sources funds equal in amount to those received under the act for any fiscal year. Each of the States complied with this requirement of the act and qualified for its

authorized allotment during the fiscal year 1937. As an average the funds available from State sources were many times larger than the amounts necessary to meet the offset required by the Bankhead-Jones Act. The exact total funds from State sources will not be accurately known until all financial reports due within the next few months are received, but will probably amount to nearly $12,000,000 or slightly in excess of $2 from State sources to each $1 of Federal-grant funds. In the fiscal year 1936, funds from State sources were increased over 1935 by $745,853. It is expected that the final figures on total from State sources for 1937 will show an increase as compared with 1936.

The grand total available to the State experiment stations from all sources, Federal-grant funds, State appropriations, sales receipts, and supplementary funds, for 1937 was more than $17,000,000. This fund was used for the maintenance of some 7,500 research projects covering practically every major interest of agriculture and rural life.

ADMINISTRATION OF FEDERAL GRANTS TO THE STATIONS

As usual, representatives of the Office visited each of the State experiment stations to review the work and expenditures under the Federal funds, to examine methods of accounting for these funds, and to assist with special reference to coordination of work under Federal-grant and other funds.

In connection with the annual review of research under Federal funds, members of the Office were given opportunity to inform themselves more fully regarding the station work as a whole and to aid by direct conference in coordinating the work of the stations with that of the Department and other research agencies and with the various National and State relief and adjustment activities (p. 6).

Within the Office much attention was given to formulating uniform methods of examining and reporting on station work and expenditures and in examining and acting upon projects submitted by the stations for approval.

STATION PROJECTS AND PROGRAMS

Critical examination of research projects and programs submitted by the stations for approval as to their suitability for support from Federal-grant funds is requiring an increased amount of time and attention of the Office. During the year 487 Adams fund projects, 1,621 Purnell fund projects, and 511 Bankhead-Jones fund projects were active. Of the Adams projects 39 were new and 10 revised, of the Purnell projects 200 were new and 55 revised, and of the Bankhead-Jones projects 178 were new and 16 revised. In addition to the task of passing upon these projects, much time and thought were given, in cooperation with the stations and bureaus of the Department, to readjustment and strengthening of research programs involving State and Department, as well as Federal-grant funds.

A fuller review of station projects, programs, and accomplishments during the year will appear in the report of the Office on the agricultural experiment stations for 1937.

INSULAR STATIONS

The Office continued, as in previous years, to administer and supervise the work of the Federal experiment stations in Hawaii and Puerto Rico.

HAWAII STATION

The Hawaii station made substantial progress during the year in strengthening its organization and personnel, broadening and improving its research work, and developing more effective Federal and Territorial relationships.

The gradual merging of the Federal and Territorial stations into one research unit as agreed upon in 1928 was continued and will be fully consummated in another year. Direct appropriations to the Federal station, through the Office of Experiment Stations, in accordance with this agreement were reduced from $32,066 in 1936 to $12,066 for the fiscal year and will cease June 30, 1938.

The total income for the station during the year was approximately $317,541. This consisted of $15,000 Hatch funds, $15,000 Adams funds, $20,000 Purnell funds, and $4,593 Bankhead-Jones funds, all of which are Federal-grant funds for agricultural research; $46,468 Territorial funds from all sources; $12,066

direct appropriation for the Federal station through the Department of Agriculture; and approximately $204,414 from the funds originally made available under sugar-processing tax fund allotments and continued by the Supplemental Appropriation Act, fiscal year 1936 (49 Stat., 1116). In accordance with the original sugar-processing tax orders, these supplemental funds were allotted to seven projects, approximate expenditures on which during the year were as follows: Taro investigations, $17,805; liver fluke eradication, $14,439; rat-abatement campaign, $66,593; development of truck farming and improvement of marketing facilities for farm products, $31,560; development of livestock feed, $33,451; development of tropical fruits and nuts, $28,924; and promotion of the poultry industry, $11,642.

The efforts of the station to develop a more diversified agriculture are resulting in progress. As a direct result of research financed by tax-fund order no. 4, taro investigations in the Territory of Hawaii, a corporation was established in the spring of 1937 to manufacture taro flour and other products from the starchy corm of the taro plant. This company had a plant in operation in July 1937 and provided a market for taro produced by small farmers. In addition, the ranching industry has been assisted through improvement of pastures, importation of new pasture grasses, and feeding experiments with local feeds including molasses. Progress has been made through research on propagation of tropical fruit and nut trees which will aid these incipient industries in making further advances.

Cooperation with the Bureau of Chemistry and Soils on a soil survey and on certain chemical problems and with the Bureau of Biological Survey on rodent problems was continued.

PUERTO RICO STATION

The Federal station at Mayaguez, Puerto Rico, made notable progress in strengthening its work and in developing effective cooperative relationships with Federal, Territorial, and other research agencies.

The major objectives of the work of the Puerto Rico Experiment Station included improvement of agriculture in the island and aid in projects of benefit to the agriculture of the continental United States. The station continued cooperation with the Bureau of Plant Industry of the Department in production of insecticidal plants the essential properties of which may prove valuable as substitutes for some of the more toxic insecticides now in common use. Similarly, work on quinine plants was continued in cooperation with that Bureau. The station continued to cooperate with the Bureau of Entomology and Plant Quarantine in the introduction of beneficial insects parasitic or predaceous upon crop pests of the island. Further work was also done in cooperation with the Bureau of Animal Industry on animal parasites. A soil-erosion survey made by the Soil Conservation Service was completed.

The station is serving as a research center for agricultural scientists of the continental United States by furnishing facilities and cooperation for their research activities which require or may profit from studies or trials under tropical conditions. The very promising work on production and utilization of the bamboo was retarded by infestations of the powder-post beetle. However, species of bamboo have been introduced which appear to be resistant to this beetle.

Under a cooperative agreement the Puerto Rico Reconstruction Administration maintained a workers' reconstruction camp on the upland Las Mesas property of the experiment station during the year. This camp is somewhat similar to a Civilian Conservation Corps camp in the continental United States and was operated upon projects to develop methods of soil conservation and land utilization under the conditions of unusual rainfall, steep hillsides, and tropical crops representative of Puerto Rico. A second agreement of cooperation with the Soil Conservation Service brought technologists of that Service into joint administration of the project.

Very satisfactory progress continues to be made in coordinating the work of the Federal station at Mayaguez and that of the Insular station at Rio Piedras.

The regular appropriations for the Federal station at Mayaguez were $57,245. In addition, the station continued responsibility for research undertaken with funds originally made available by Puerto Rico tax-fund order no. 5 and continued by the Supplemental Appropriation Act, fiscal year 1936 (49 Stat., 1116), the funds being available until expended. Expenditures under this fund for the fiscal year 1937 amounted to $33,595, making a total budget of $90,840.

SPECIAL RESEARCH FUND, DEPARTMENT OF AGRICULTURE

The "Special research fund, Department of Agriculture", authorized by title I, section 4, of the Bankhead-Jones Act, approved June 29, 1935, is available, under the terms of the act, one-half for special research projects of the Department and one-half for the establishment and maintenance of research laboratories and facilities in the major agricultural regions at places selected by the Secretary and for the maintenance of research at such laboratories. In accordance with the authorization under the act, $784,000 was made available for these purposes during the year.

REGIONAL LABORATORIES

The policy adopted in 1936, following the passage of the Bankhead-Jones Act, was continued in the selection of regional laboratory projects, the planning of the research programs, and coordinating the research of the laboratories with research under other funds in accordance with the provisions of the act. This policy provides that the Secretary shall have the joint suggestions of the State station directors by major agricultural regions along with suggestions from bureaus of the Department as a basis for selection of regional laboratory projects. It provides further that each approved laboratory project shall be organized and the work planned in cooperation with the agricultural experiment stations of the major agricultural region concerned in the work of such laboratories.

As the agency responsible for the administration of the special research fund, the Office of Experiment Stations cooperated with the bureaus and the State experiment stations in the further development of the three regional laboratories established during the previous year, and in the selection of projects and development of plans for establishing three additional laboratories during the year 1937.

PROGRESS OF LABORATORIES ESTABLISHED IN 1936

The first regional laboratory project under the act was approved November 30, 1935, to be located near Charleston, S. C., for research to develop improved varieties of vegetable crop plants having superior adaptation to the southeastern region of the United States. By the close of the fiscal year 1937 the laboratory buildings, greenhouses, superintendent's residence, and other structures planned for immediate use were completed and in use. About 170 acres of land had been made ready for use, and during the year, while the physical plant was being developed, plant materials to serve for research in breeding and improvement of vegetable crop plants were assembled. These included over 700 strains of cabbage, cauliflower, and related plants; over 300 accessions of watermelons; several hundred strains of tomatoes; and several hundred strains of beans and peas. These were grown and tested for tolerance to weather conditions and diseases.

The laboratory project for research into the industrial utilization of the soybean and soybean products was approved February 20, 1936, to be located at the University of Illinois, Urbana, Ill., under the leadership of the Bureau of Chemistry and Soils. By the close of the fiscal year 1937, laboratory space was arranged for, equipment and other facilities assembled, technical staff was selected and appointed, and satisfactory relationships were developed with the State experiment stations of the north-central region.

While the physical plant was being developed, the Bureau of Plant Industry, in cooperation with 5 State experiment stations, grew more than 500 samples of seed in 5 States to study the effect of varietal, soil, fertilizer, and climatic factors on the chemical constituents of the soybean. Over 150 samples of 9 varieties of soybeans were analyzed by the laboratory. While it is too early to attempt conclusions, this combined agronomic-chemical work and beginnings made by the laboratory in other lines of research may be reported as satisfactory. The interest and cooperation of the 2 bureaus and the 12 experiment stations was excellent.

The regional laboratory project for pasture improvement in the northeast region was approved February 20, 1936, to be located at State College, Pa. During the fiscal year 1937 major attention was given to the completion of the physical plant, including the laboratory, assembling and installation of equipment, the selection of research personnel, and development of the research program and relationships with the directors of the Northeastern States. The

Pennsylvania Agricultural Experiment Station assigned for the use of the laboratory 40 acres of land for nursery plantings, plat experiments, breeding work, and other purposes. Over 30,000 seedlings, including some 16 species, were grown in the greenhouse and transplanted to the nursery as a beginning for the research work.

THREE ADDITIONAL LABORATORIES ESTABLISHED

Three additional regional laboratory projects were approved during the year and the proposed program of investigations and relationships with the State experiment stations of the respective regions were worked out in cooperation with directors of the stations concerned.

After full consideration and agreement of directors of the southeastern region and representatives of the Department as to the basic need for research to develop methods of control for diseases and parasites of domestic animals in this region, a regional laboratory project for research in this field was approved. By joint agreement with the States, this laboratory was located at the Alabama Polytechnic Institute, Auburn, Ala. This location is suitable as to technical requirements of the proposed research and is central for the 13 States cooperating as regards transportation. The State of Alabama, through the Alabama Polytechnic Institute, deeded to the Department of Agriculture approximately 40 acres of land as a site for the laboratory and necessary outbuildings. Plans and specifications for the buildings and improvements were approved and contracts awarded for construction before the close of the fiscal year.

Following joint consideration by the directors of the North Central States region and representatives of the Department, a regional laboratory project for the improvement of swine through breeding methods was approved for this region. This project is organized in cooperation with the State experiment stations of the region on the basis of active participation by enough of the State stations to make available land and swine sufficient to meet the requirements for effective research as decided upon by the scientists of the 13 States and the Department. Active participation was formulated and agreed upon with the State experiment stations of Iowa, Nebraska, Missouri, and Minnesota. Under the project plan and agreements, these States are to furnish land and swine for use in the research project. By joint agreement the laboratory headquarters are located at the Iowa State College of Agriculture and Mechanic Arts. This cooperative arrangement will provide physical plant facilities which would be difficult to provide in any other way and assures coordination of the research under the laboratory project with research under other funds as far as practicable in accordance with the terms of the Bankhead-Jones Act.

A laboratory for the improvement of sheep for western ranges through the application of breeding methods was agreed upon in cooperation with the directors of the 11 Western range States. This laboratory is located at Dubois, Idaho, in conjunction with the facilities the Department has already established there for investigations with sheep under regular funds. The location was decided upon by joint agreement primarily because summer, spring, fall, and winter range necessary is already available and would be difficult to provide elsewhere. The research program and cooperative relationships agreed upon with the States provide for coordination of the research of the laboratory with research of the State stations and the Department under regular funds. Because of the importance of sheep under somewhat similar conditions in Texas, the experiment station of Texas is included with the 11 Western States in the planning and carrying forward of this project. Plans and specifications for the laboratory and other necessary improvements were approved before the end of the fiscal year and contracts awarded for construction of the major units.

In the selection of these new laboratory projects and in the planning of the research program and cooperation with the State stations of the regions, the Department has had the whole-hearted active interest and help of the State stations. While it is too early for conclusions as to the effectiveness of projects thus organized for coordinated attack on problems of regional or national significance, the plans would seem to be logical and promising of most effective results with a minimum of additional cost for the kind and scope of research undertaken. Considering the many agencies involved in the coordinated attack and the comprehensive problems undertaken, the progress in the development of the regional laboratory program would seem to be highly satisfactory.

SPECIAL RESEARCH PROJECTS

In the report of the Office of Experiment Stations for 1936, the preliminary work of the Department with reference to further development of a sound program of research projects under the special research fund provided by the Bankhead-Jones Act for the Department of Agriculture was reviewed. As there stated, the total of what appeared to be meritorious proposals for research under these funds was greatly in excess of the work that could be undertaken during 1936. With the cooperation of the research bureaus and in conference with the Secretary, a special advisory committee appointed by the Secretary for this purpose developed a program of selected projects believed to be of outstanding merit and in accordance with the intent and purpose and provisions of the Bankhead-Jones Act in authorizing this special fund. A total of 32 research projects, involving research workers of 10 bureaus of the Department and much cooperation with State experiment stations, was approved.

With the help of the research bureaus of the Department, the program outlined by the special committee following the passage of the Bankhead-Jones Act was reviewed in the light of conditions and needs in 1937 and a total of 34 projects received allotments of funds and were active during the year. Of this total seven were new projects approved and initiated during the fiscal year. As indicated in the report for 1936, 5 of the 32 projects approved for that year were short-time projects completed within that year.

The 34 projects active in 1937 involved research by workers of 11 research bureaus of the Department and formal or informal cooperation with many of the State stations. Individual projects involved research workers of as many as three bureaus and seven State experiment stations.

In organizing the research on an approved project, every attempt is made to develop cooperation and participation of the subject-matter bureaus which should participate in order to provide for a well-rounded, coordinated research and to secure cooperation and participation on the part of State experiment stations in projects which can be advanced most effectively with State participation, through the furnishing of either available facilities or of services of staff members of the State stations.

COORDINATION AND COOPERATION

With the continued excellent cooperation of the specialists of the Department and the State experiment stations, it is believed that further substantial progress was made during the year in expanding cooperative-coordinated attack in research work of the Department and of the State experiment stations. Efforts in this direction were aided by the provisions of the Bankhead-Jones Act with its additional funds and through the assignment to the Office of Experiment Stations of the new functions of Director of Research and the administration of the Federal funds under the Bankhead-Jones Act.

The State agricultural experiment stations continued to work closely with other State agencies and local organized groups, with each other in regional groups, and with this Department individually and in regional and national groups in efforts to plan and coordinate their research. In carrying out its functions, this Office examined, approved, and recorded nearly 1,200 new or revised formal cooperative research projects between bureaus of the Department and the State experiment stations. These covered nearly 1,000 major research undertakings. All of the State agricultural experiment stations, and all but one of the research bureaus of the Department, again participated. There were also many informal cooperative agreements between organized regional and national groups of stations, and in some cases between such groups and this Department. Some of these informal undertakings were of major importance to specialized phases of agricultural production and rural life and were gradually assuming formal status.

Certain regional and national cooperative studies, which began on an emergency basis as recovery measures during the earlier depression years, were modified to meet the more permanent requirements of American agriculture. Important phases of the national study of adjustments in farming by regions and type-of-farming areas from the standpoint of national agricultural adjustment in which all of the State stations cooperated with the Bureau of Agricultural Economics, the Agricultural Adjustment Administration, the Soil Conservation Service, the Forest Service, and the Resettlement Administration were

reconsidered and directed into more specific studies in relation to agricultural conservation and adjustment.

Under the procedure agreed upon for establishing regional laboratories, the State experiment station directors in each of these major agricultural regions acted as a group in considering proposals for regional laboratories to be established in the respective region and in making recommendations to the Department. For each laboratory established, the cooperative agreement entered into by the Department and the experiment stations concerned provides for integration of research at the laboratory with research at the experiment stations in the region and for the joint revision and reformulation annually of the research program.

The study during the year of input as related to output in milk production is typical of the cooperative research into broadly important regional or national problems initiated under the provision of the Bankhead-Jones Act for research by this Department other than at regional laboratories. In this undertaking 2 of the Department's bureaus and 10 of the State experiment stations, together with other organized State groups, cooperated in an attack on the problems involved.

Federal and State agencies completed during the fiscal year the national cooperative survey of plant and animal improvement which was begun during the previous year, and in which the Office assisted as a clearing agency for the cooperation. This provided the basis for material published in the Yearbook of Agriculture for 1937 regarding the character and availability of superior germ plasm in the different groups of economically important plants and animals not covered in the 1936 Yearbook.

A similar national cooperative survey of research in soil science and related problems, involving all Department bureaus concerned with soils, soil science, and land use, and all of the State agricultural experiment stations, was started during the year. This cooperative study is bringing together available information on soil science and should exercise a favorable influence on the further planning of studies in the subject as they bear on modern soil management and land-use practices.

The year saw further expansion of coordination of research at the State experiment stations with that of this Department relating to tobacco and cotton diseases and spray injury. The annual conferences of the Tobacco Disease Council and of the Cotton Disease Council showed an increasing volume of coordinated work and more rapid progress toward the solution of serious national plant-disease problems. Twelve State stations and the Bureau of Plant Industry are now engaged under formal or informal cooperation in the study of the production, improvement, and diseases of cotton.

The widespread efforts in crop improvement and in the development and stabilization of production methods were continued and expanded. Typical of these were the cereal crop improvement investigations which were extended to include 20 States and the investigations of machinery for the mechanical application of fertilizers to cotton, potatoes, sugar beets, and canning crops and for the production and harvesting of sugar beets, cotton, and corn, which were extended to include 15 States. Other similar widely cooperative researches were the study of income parity for agriculture, the concentrated fertilizer investigations, and the studies of cereal and forage-crop insects and of parasites of the oriental fruit moth.

The memorandum of understanding covering research relationships between the Soil Conservation Service and the State experiment stations, adopted during the previous year, became effective with 45 of the experiment stations during the year and research project agreements, subsidiary to the understanding and covering definite lines of soil-conservation research, were entered into with 24 State stations. Thus through mutual understanding and joint action of the Federal and State research agencies concerned a program is being developed to take account of major national as well as regional and local problems of soil conservation.

The advantages of a coordinated attack upon home economics research problems of interest or significance to regional groups were demonstrated by the progress made during the year in the program of research among several experiment stations of the North Central States on the nutritional status of college women, which is being carried out under a formal memorandum of agreement. The large amount of data thus being obtained through simultaneous studies with uniform methods in several States is laying the ground work for determining regional differences in the nutritional status

of this age group, if such exist, for the establishment of new and valuable standards for the betterment of the nutrition, and for production planning to meet consumption needs. In a similar way cooperation was developed among the northeastern stations for research on certain phases of textiles.

Cooperative studies on other agricultural problems included several important new undertakings, among them studies in animal breeding, plant-disease control, home economics, and farm-home equipment. At a conference initiated by experiment station workers on the root knot nematode problem in February 1937, a permanent coordinating committee, consisting of research workers from this Department and several experiment stations and a specialist from this Office, was formed to work out means for more effective group attack on the root knot trouble. A number of State stations and Department entomologists took steps during the year to organize the Tobacco Insect Council and to launch certain cooperative research projects in the subject.

For the stations in the Northeastern States, a committee for nutrition was working toward the coordination of existing research projects in the region dealing with important phases of vitamin C in human nutrition, and a memorandum of understanding for a coordinated attack on this problem was entered into by three stations. Nutrition research workers from five Northwestern States also met in the spring of 1937 to organize cooperative research on the problem of vitamin C requirements. Projects were begun in two States and plans for the further coordination of this research are to be developed at a second conference to be held in October. Regional attacks on the same problem in the Northwest and the Northeast thus will afford an opportunity for the study of regional, and possibly climatic, differences in vitamin C requirements.

A closer connection between research in the States and in the Bureau of Home Economics in the field of household equipment was established during the year. In January 1937 a conference in household equipment, attended by research workers from five State experiment stations, the Bureaus of Home Economics and Agricultural Engineering, the Tennessee Valley Authority, the Works Progress Administration, the Rural Electrification Administration, and specialists of this Office, was devoted to the evaluation of present studies in the field, the planning of needed studies, and the drawing of specifications for different types of household equipment based upon research findings. The need for a standardization of test methods was brought out and committee recommendations in this connection were presented at a second conference in June 1937. These joint efforts have resulted in a more effective attack on home-equipment problems by the cooperating agencies than has been possible heretofore.

In numerous other regional and national studies of a long-time character, this Department cooperated with from 4 to 29 experiment stations. The total number of formal cooperative studies per station ranged from 8 to 46.

PUBLICATIONS

The Office continued as in previous years to issue publications considered essential to proper administration of the Federal acts and to furnish such aid and information as it was thought would best promote the purposes of agricultural research.

EXPERIMENT STATION RECORD

The publication of Experiment Station Record was continued with a staff including, on a whole-time or part-time basis, practically all of the specialists in the Office. Appearing monthly and with an average of 150 pages per issue, the Record continued as heretofore to make available to experiment station and Department staffs, and incidentally to an even larger number of teachers, extension workers, students, writers, and others, brief summaries of the current publications of the stations and the Department, the contributions of workers in these institutions appearing in scientific journals and other channels, and a considerable volume of other literature pertaining to research in agricultural science or otherwise of interest in this field. This is a service carried on continuously since 1889, never attempted by other agencies. It performs the double function of providing systematically and in convenient form for reference information as to what has already been accomplished and of helping to disseminate widely the current results of such research throughout the world.

Under the general plan in operation for several years, volumes 75 and 76 were completed during the year. These volumes contained 3,343 and 3,501 abstracts, respectively, and in addition the customary editorials, news notes, and indexes.

The compilation of a general index for volumes 61 to 70 (1929–1934) was completed, and the index was in press at the close of the year. The series of general indexes has been found to be of great convenience for reference purposes.

A number of readjustments was effected during the year in the assignment of personnel for abstracting. Mabel A. Dickson was appointed associate in home economics on September 16, 1936, making possible a more complete covering of the fields of foods and human nutrition, textiles and clothing, and biological chemistry.

Cooperation with Biological Abstracts was again restricted to the supplying of carbon copies of abstracts of experiment station and Department publications.

The number of abstracts published in Experiment Station Record during the year was somewhat larger than in the previous year, but the steady increase in the literature resulting from this continued development of agricultural research intensified an already acute problem as to selection of material.

When the present space limits of 1,800 printed pages were adopted in 1911, the aggregate income of the State experiment stations was less than $4,000,000 and their scientific staffs numbered less than 1,600 workers. In 1936 their staffs had increased to over 3,800 and their aggregate revenues to over $16,000,000. The station output in publications has likewise increased tremendously, partly in the stations' own series but even more largely through scientific journals. Other research agencies in the field of agriculture and home economics, including the Federal Department of Agriculture, have shown a similar increase in activity, and such subjects as agricultural economics, rural sociology, agricultural engineering, genetics, and home economics have made practically their entire development during the past quarter of a century.

Under these circumstances the policy followed was that of a relatively complete review of all publications by experiment station and Department workers and the utilization of the remaining space largely on a basis of potential usefulness to these groups. Despite a more rigid selection than at any previous period, at the close of the year material sufficient for at least two additional issues was awaiting publication for which no space was available. With depression cuts in State appropriations being restored and the crest of the Bankhead-Jones Act funds still ahead it has become increasingly evident that considerable enlargement of space will be essential if existing policies are to be maintained.

OTHER PUBLICATIONS

Other publications of the Office during the year gave, as in previous years, comprehensive information regarding personnel, organization, facilities for research, progress and results of work, publications, and finances of the stations. The following is a complete list of these publications of the Office:

Report of the Chief of the Office of Experiment Stations, 1936, by James T. Jardine; and Report on the Agricultural Experiment Stations, 1935, by J. T. Jardine, W. H. Beal, et al.

Miscellaneous Publication 251, A History of Agricultural Experimentation and Research in the United States, 1607–1925, Including a History of the United States Department of Agriculture, by Alfred Charles True.

Miscellaneous Publication 254, Workers in Subjects Pertaining to Agriculture in Land-Grant Colleges and Experiment Stations, 1936–37, by M. A. Agnew.

Hawaii Station Circular 11, The Gizzard-Worm, and Its Transmission to Chickens in Hawaii, by Joseph E. Alicata (published in Hawaii); and Report of the Hawaii Agricultural Experiment Station, 1936 (published in Hawaii).

Report of the Puerto Rico Experiment Station, 1935 (English and Spanish editions). Also reprint of English edition.

Separates from Report on the Agricultural Experiment Stations, 1935—Foods and Nutrition and Household Management, by Sybil L. Smith; and Fields Crops, by Henry M. Steece.

Journal of Agricultural Research paper on Nutritive Value of the Protein of *Cajanus indicus*, by Carey D. Miller and Ruth C. Robbins.

MANUSCRIPTS PREPARED FOR PUBLICATION

Publications in press at the close of the year included several numbers of Experiment Station Record; General Index to Experiment Station Record, volumes 61–70, 1929–34; Report on the Agricultural Experiment Stations, 1936; a separate from the report for 1936 on Foods, Human Nutrition, and Problems Related to the Home, by Sybil L. Smith; and Report of the Puerto Rico Experiment Station, 1936.

In addition, two manuscripts—Some Naturalized Grasses in Hawaii, by L. D. Whitney, and Methods of Evaluating the Macadamia Nut for Commercial Use and the Variation Occurring Among Seedling Plantings in Hawaii, by J. C. Ripperton, R. H. Moltzau, and D. W. Edwards—were reviewed for publication in Hawaii.

LIBRARY AND BIBLIOGRAPHICAL SERVICE

The library of the Office, in cooperation with the Department Library and the Extension Service, maintained as in previous years files of the publications of the stations, the United States Department of Agriculture, and the extension services of the State colleges. Three thousand two hundred publications were received and recorded.

The publications of the stations and the Department, current for the year, were collected and prepared for the use of the Office staff for abstracting in Experiment Station Record.

From the 14,000 books and approximately 80,000 separate numbers of periodicals made available by the staff of the Department Library, 2,522 books and 30,000 periodicals were selected for circulation in the Office of Experiment Stations and the Extension Service. Many of these were examined for experimental and research data, and submitted to the Record staff for review. From all publications assigned, 6,844 abstracts were published in the Record.

The eighth supplement to Department Bulletin 1199, a list of station bulletins published in 1935–36, with index, was prepared for publication. The list contains 1,171 titles. The lists of articles appearing in current scientific journals, contributions by station workers, were continued and, by arrangement with the Department Library, published monthly in its Library Notes. From 138 periodicals examined, 2,634 titles were listed, including 74 from the Journal of Agricultural Research, which were contributed by 25 stations. The mimeographed lists of station publications received currently in the Office were compiled monthly for distribution to agricultural colleges, stations, libraries, other institutions, and to individuals having interest in agricultural research. There were also compiled and published in Library Notes monthly lists of the State extension publications.

Owing to increased publication and the greater demand for bibliographical information, the work of the library was especially heavy during the year. The files of the station publications were much consulted by workers throughout the Department, particularly those in the newer agencies. Bibliographies and short lists on specific subjects were compiled and publications were supplied from the duplicate files in the Office to answer the requests for information and publications on agricultural subjects. Much time was given to the search for bibliographical data for which request was made. Other work accomplished included the preparation and filing of 16,535 index cards in all catalogs in the library and the assembling for binding of 229 volumes of station and Department publications for the Office and for the Hawaii and Puerto Rico stations.

SPECIAL SERVICES

Calls for special services in aid of research in addition and incidental to the regular functions of the Office claimed an increased amount of time and attention during the year from Office specialists. These calls included such matters as conferences with representatives of the different bureaus of the Department and of other departments, and of the experiment stations and other State agencies; service on various committees within and without the Department; preparation of special reports, papers, and compilations of information relating to the organization and work of the Office and the experiment stations; and consideration of various aspects of national, regional, and local problems.

As heretofore, the Chief of the Office took an active part in such services. He served on various committees of the Department and of the Association of Land-Grant Colleges and Universities, namely, that on experiment station organization and policy, and the joint committee on projects and correlation of research. Planning of new research under the Bankhead-Jones Act and administration of the special research fund provided by that act for the Department and advice as to use of State funds claimed a large amount of his time and attention and that of other specialists of the Office.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - Price 5 cents

REPORT OF THE CHIEF OF THE BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE, 1937

United States Department of Agriculture,
Bureau of Entomology and Plant Quarantine,
Washington, D. C., September 15, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I submit herewith a report of the work of the Bureau of Entomology and Plant Quarantine for the fiscal year ended June 30, 1937.

Sincerely yours,

Lee A. Strong, *Chief.*

CONTENTS

INTRODUCTION

The organization of the Bureau activities has continued along substantially the same lines and with the same division leaders as during the previous year. The special investigations begun last year with allotments from processing taxes collected in Hawaii and Puerto Rico were concluded. A small amount of funds available for work in Hawaii remains available and will be used for special studies having a direct bearing on the control of fruitflies in Hawaii during the fiscal year 1938.

As in the preceding year, activities concerned with the eradication and control of plant pests were materially expanded by allotments of emergency funds for relief. The results of the work done under these special allotments are discussed under appropriate headings and include the following activities: Gypsy month control, brown-tail moth control, Dutch elm disease eradication, barberry eradication, white pine blister rust control, citrus canker eradication, phony peach disease control, eradication of peach mosaic, elimination of wild cotton in southern Florida, and the destruction of Thurberia plants in southeastern Arizona.

Camps operated by the Civilian Conservation Corps have cooperated in the control of certain insect pests and plant diseases. These activities have been made a regular part of the activities of the camps, the technical advice being supplied by this Bureau. The active project of some few camps has been directed entirely toward the control of such pests, including the gypsy moth in the New England States, and toward the eradication of the Dutch elm disease in New Jersey. Some camps have cooperated in the control of grasshoppers and the Mormon cricket. Others have engaged in the control of insect pests in forests. To aid in making the surveys needed to plan such work, small allotments were made to the Bureau from appropriations for emergency conservation work to conduct investigations having a direct bearing on the work done by the camps. A small allotment was also made to enable the Bureau to advise camps regarding the control of mosquitoes, particularly the work done from camps in the States of Delaware and Maryland.

PUBLICATIONS AND EDITORIAL WORK

During the year 506 manuscripts were presented for publication and 463 were approved, 83 being submitted to the Department for publication and the remaining 380 to outside journals. There remained on hand at the end of the year 142 manuscripts, 103 of which were under consideration in the Bureau, 27 were in the Office of Information awaiting publication by the Department, and the remaining 12 were in press at the Government Printing Office. Of the 103 in the Bureau, 52 were being considered for publication by the Department and the remaining 51 for publication in outside periodicals.

LIBRARY

The loan and reference work connected with supplying books and periodicals for the scientific staff of the Bureau has increased approximately 15 percent. As a part of these activities the library staff has prepared several special bibliographies to aid the investigators, including a list of articles reporting the effect of electricity on insects, and one listing papers on ants attacking forests, with special reference to *Formica exsectoides*. Entomology Current Literature has appeared regularly every 2 months, with 135 pages this year as compared with 117 last year. The outstanding bibliographic work for the year was the completion of Index V of American Economic Entomology for 1930–34, a compilation of some 40,000 references. This manuscript is to be published with the cooperation of the American Association of Economic Entomologists and is expected to be printed late this fall.

INSECT PEST SURVEY AND INFORMATION

The survey added to the permanent files on the distribution and abundance of insects 12,000 notes on American insect pests and 7,000 notes on foreign pests, bringing the total now available for consultation to 259,650 notes. The work of the year brought the number of insect pests of foreign countries not known to be in the United States to over 20,000 kinds, which now exceeds the number of insect pests recorded from this country by nearly 1,000.

The monthly Insect Pest Survey Bulletin was augmented by supplements on Insect Pests from Costa Rica in 1935, Colonization of Parasites of the European Corn Borer, Chinch Bug Abundance in Hibernation Quarters, European Corn Borer Status in 1936, European Corn Borer Surveys, Distribution of the Species of Grasshoppers in the 1936 Outbreak, Hessian Fly Infestation, Alfalfa Weevil Survey, The Periodical Cicada, and Distribution of Grasshoppers in 1936.

One hundred and twenty-eight articles on entomological and quarantine subjects were released to the press, and 70 radio talks were put on the air. The preparation of film-strip material covered seven new subjects. Two motion pictures were completed, one on the periodical cicada and one on the screwworm. Entomological exhibits were shown at the International Exposition in Paris, at the American Medical Association in Atlantic City, N. J., at the annual meeting of the American Association of Economic Entomologists in Atlantic City, N. J., at the North American Wildlife Conference in St. Louis, Mo., at the International Horticultural Exposition in Chicago, Ill., at the Florida State Fair, at the Twelfth Annual National Shade Tree Conference in Boston, Mass., at the National Association of Exterminators and Fumigators in Cleveland, Ohio, and at the American Royal Livestock Show at Kansas City, Mo. Two new State fair exhibits were prepared on different phases of termite control.

Cooperative extension work in entomology was supervised under the direction of the Bureau and the Office of Cooperative Extension Work.

Approximately 222,600 copies of publications were distributed, exclusive of those sent out on regular mailing lists and miscellaneous mimeographed material.

FRUIT INSECT INVESTIGATIONS

APPLE INSECTS

In the search for insecticides which may be substituted for lead arsenate in the control of the codling moth, approximately 250 new compounds, chiefly organic materials supplied by the Division of Insecticide Investigations, were given preliminary test at the Beltsville, Md., laboratory. In practically all cases the results were so poor that the materials were eliminated from further consideration; a few warrant further laboratory study.

Certain nicotine combinations, particularly nicotine-bentonite, have continued to give encouraging results in field and laboratory, and one form of this material is being tested on a semicommercial scale in orchard plots of about 2½ acres each in southern Indiana. A number of growers have been very much impressed by the results with the nicotine bentonite and are using it on portions of their acreage. If found practical, this material will be especially useful on early varieties such as the Yellow Transparent, which does not lend itself very readily to the washing process for residue removal. The high cost of nicotine-bentonite is, in part at least, offset by additional benefits in the control of other insects and by the more favorable effect on the tree than results from the use of lead arsenate.

In the Pacific Northwest phenothiazine has continued to give outstanding control of the codling moth, but the difficulties formerly pointed out have not yet been overcome. The chief disadvantage is the serious skin irritation suffered by some of the men doing the spraying, and by the men who later work in the trees thinning or harvesting. A minor disadvantage is a more or less unfavorable effect on the coloring of the fruit. In the East and Middle West the results with this material are still irregular but have offered sufficient encouragement to justify further work.

At Vincennes, Ind., more use is being made of a "field-laboratory" method of testing insecticides. Field plots are laid out and sprayed as usual, and at intervals the apples are taken to the laboratory and artificially infested with a known number of newly hatched codling moth larvae. The experiments are thus independent of the natural infestation, which is often very irregular within the same orchard. This method gives a running picture through the season of the relative effectiveness of the materials tested. The detailed information resulting from the use of this method is of great value in supplementing that obtained by the usual methods of field testing, in which the results are judged largely by the condition of the fruit at harvest time.

The program of recolonization of the codling moth parasite *Ascogaster quadridentatus* Wesm. has been completed. A large number of living adults of the eastern parasite *Phanerotoma tibialis* Hald. have been sent to Parma, Idaho, for liberation in an orchard which is being used at that point for a parasite project in which this Bureau is cooperating with the Idaho Agricultural Experiment Station, and a small colony of the native parasite *Aenoplex carpocapsae* Cushm. has been sent to the same place. The European codling moth parasite *Ephialtes extensor* Tasch. was received in small numbers from the Division of Foreign Parasite Introduction and was propagated in the laboratory, and small colonies were liberated in New Jersey and Idaho. Studies of the cocoon parasite *A. carpocapsae* showed that breeding nearly ceases during July and August, but becomes normal again in September. After being quite abundant in certain orchards in southeastern Illinois in 1935, this species virtually disappeared from the same orchards in 1936.

The program of distribution of *Aphelinus mali* Hald., a parasite of the woolly apple aphid, to the Western States in which this effective beneficial insect was not already present, has been completed.

Studies of the biology and seasonal history of the pear thrips in the Northwest have indicated that the time of emergence from hibernation, with reference to the blooming period, varies considerably from year to year; and this makes the proper timing of spray applications difficult, although, when properly timed, applications of nicotine in several combinations have given very large reductions in the losses caused by this insect. Studies of the part played by

the thrips in the production of the russet or scab type of injury to prunes did not give conclusive results. It is apparent that both the thrips and mechanical injuries are in part responsible for this condition, but their relative importance has not yet been fully determined.

PEACH INSECTS

During the summer of 1936 a study was undertaken of the insects that infest peach orchards where the phony peach disease is found under conditions of natural spread, in an effort to obtain circumstantial evidence pointing to an insect or insects which may be responsible for the spread of this disease. In order to carry on this work a mobile research laboratory has been installed in a trailer of the usual tourist type. This is drawn by a motortruck which carries a power unit to furnish electric current for lighting and for the operation of equipment. In less than 8 months during 1936 this laboratory traveled more than 10,600 miles and collected 3,709 lots of insect material from peach orchards at 60 locations in 11 States. To have conducted the same amount of work by the use of the usual type of laboratory quarters would have required several times the personnel, and the maintenance of a number of seasonal or temporary laboratories. In the spring of 1937 a second unit was purchased and equipped for use in a similar survey of peach orchards in areas affected by the peach mosaic disease in the Southwestern States.

As in previous years, special attention has been given to the introduction and colonization of foreign and domestic parasites of the oriental fruit moth, in cooperation with numerous State agencies. During the calendar year 1936 eight shipments of parasite material were received from Japan, imported by the Division of Foreign Parasite Introduction. Out of this material 30,406 living adults of 15 different species of primary parasites were reared. Many of these were further propagated in the laboratory. During 1936, 186 releasements of 42,138 parasites were made in 14 different States. Two hundred and fifty-eight recovery collections were made by the Bureau and cooperating State workers in 16 different States. This work is being continued during the calendar year 1937, with greater emphasis on recovery collections in the vicinity of previous releases, in order to obtain more complete information on the status of the introduced parasites.

In field experiments with substitutes for lead arsenate for the control of the plum curculio, both barium fluosilicate and cryolite caused considerable damage to peaches, similar to the injury that occurred during the season of 1935, in spite of the fact that the materials were used in fewer applications than in 1935. The foliage was uninjured.

Of a number of water-soluble compounds tested against the peach borer, dichlorethyl ether has given a very high degree of control when applied during February and March. At higher temperatures in both fall and spring this material has given variable results, and has caused a certain amount of injury. Dichlorethyl ether has also given promise for use as a soil fumigant against the plum curculio.

GRAPE INSECTS

During the 1936 season phenothiazine gave very satisfactory control of the grape berry moth, with no seriously objectionable staining of the fruit at harvest time, but it increased somewhat a tendency toward russeting of the berries. As was the case in the experiments with codling moth control, phenothiazine had a very unfavorable effect on certain of the operators who were engaged in applying it. Several forms of nicotine-bentonite gave a considerable degree of control but caused some objectionable staining, which was particularly serious in the case of a tank-mixed nicotine-bentonite.

Further experiments with burning, carried on in the spring of 1936, confirmed the previous year's conclusions that an important reduction in the population of grape leafhoppers (*Erythroneura comes* (Say)) can be obtained by burning over the areas surrounding the vineyards in which the leafhoppers are passing the winter. In the vineyard in northern Ohio, around which the work was conducted, the leafhopper infestation was the lightest in many years, in marked contrast to other vineyards in the same locality, where the leafhopper infestations were abnormally severe.

In cage experiments phenothiazine gave practically complete kill of the grape rootworm and was apparently more effective than the arsenicals. Nicotine-bentonite, as in the preceding year, was not very toxic to the rootworm adults.

NUT INSECTS

A new laboratory was established in the spring of 1937 at Monticello, Fla., in cooperation with the Florida Agricultural Experiment Station for a study of pecan insects. At the outset special attention is being directed to the control of the pecan nut casebearer. The results obtained in the control of this insect in the spring of 1937 by the use of nicotine sulphate in combination with white oil emulsion were in line with those previously reported by the Albany, Ga., laboratory. That laboratory is now giving all of its attention to the hickory shuckworm on pecan, for the control of which adequate measures are not yet available. Special emphasis is to be placed on the relation of natural enemies to the control of this insect and to possible cultural methods of controlling it.

In experiments with the obscure scale in northern Louisiana it was learned that oil sprays have an important residual effect which is not evident until the female scales reach maturity. In orchards sprayed with 2- or 3-percent lubricating-oil emulsions during February and March, only from 1.3 to 9.5 percent of the females that reached the appearance of maturity were able to lay eggs, whereas in unsprayed trees in the same orchards, 66 to 86 percent of the mature female scales laid eggs in a normal manner. This means that it is possible to obtain satisfactory control of the obscure scale in pecan orchards with low strengths of oil emulsion, which is fortunate in view of the susceptibility of pecan trees to injury by oil sprays.

The use of lead arsenate as a spray at a strength of 3 pounds in 100 gallons of water, with 3 pounds of hydrated lime, has given very effective protection of young pecan trees from attack by the adult May beetles of the genus *Phyllophaga* in northern Louisiana. In most cases four or five applications were made at frequent intervals, but it is believed that the beetles should be well controlled by three applications put on during the early part of their feeding period. Observations have indicated that most of the protection results from a repellent action on the part of the spray. A little foliage injury developed from five applications, but this was not at all serious.

DRIED-FRUIT INSECTS

The motor-driven raisin cleaner developed by the Fresno, Calif., laboratory in 1935 was further improved, and it appears to be particularly effective in removing infestation of the raisin moth from Sultanina (Thompson Seedless) raisins, reducing the numbers of the insects in many cases more than 90 percent, and in addition removing most of the sand and debris. The paper trays on which the raisins are now extensively dried prevent infestation to a certain extent, and by the use of the paper trays, the cleaning machine, and shade-cloth covers over the boxes of raisins while temporarily stored on the ranch, the delivery of comparatively clean raisins now appears possible. Dried pears practically free from infestation were obtained by covering the fruit with cloth during the final stages of drying, confirming the results of previous experiments with various dried fruits. In Arizona, cotton-cloth extensions on the paper rain covers used for dates gave promise of success in the exclusion of certain insects that have been attacking dates in the final stages of ripening or drying while still on the tree.

The practical utilization of cotton cloth for the prevention of insect infestation of dried fruits while being held in stacked trays on the ranches is being stimulated by a cooperative project carried on by the Agricultural Extension Service of the University of California. For this work about 20,000 yards of cotton cloth have been furnished by the Agricultural Adjustment Administration as a part of a cotton-diversion program. This is being distributed to representative growers, and detailed records will be kept of the results.

In addition to the mulberry, which in most localities is practically the only food available to the raisin moth in the spring during the first generation, Mission figs were found in one locality to be of considerable importance in the building up of the raisin moth population early in the season. For the first time serious injury by larvae of the raisin moth to fresh grapes on the vines was observed.

SUBTROPICAL FRUIT INSECTS

Field experiments to determine the effect on the trees of tartar emetic when used as a bait spray on citrus trees have been continued by the Orlando, Fla., laboratory, in cooperation with other bureaus. Plots of trees have been sprayed

at 10-day to 20-day intervals with mist sprays containing 4 pounds of tartar emetic and 5 gallons of molasses in 100 gallons of spray. By the end of June 1937 certain of these trees had received 69 successive applications. Careful measurements of trunks, branches, leaves, and fruit made by workers of the Bureau of Plant Industry revealed no injurious effects, and the analyses of juice samples made by the Bureau of Chemistry and Soils showed no differences in quality that could be attributed to the use of the spray.

Much attention has been given to the development of a standardized procedure for laboratory experimentation with the California red scale in order to overcome the extreme variability which has thus far been evident in the results of experimental work. In some cases in the past the mortality of scales on individual lemons fumigated at the same time has ranged from 50 to 100 percent. Definite progress is being made toward the development of methods that will overcome this variability, giving more consistent results that can safely be used for drawing conclusions.

Populations of the California red scale derived from areas where they are said to be resistant and other populations from areas where they are said to be nonresistant to cyanide fumigation have been maintained under identical conditions in the insectary at the Whittier laboratory, but completely isolated from each other. Periodic fumigations are being made to determine the relative susceptibility of the different strains. Preliminary results indicate that, a year after the establishment of the strains in the insectary, the initial differences in susceptibility still exist.

Studies of the biology of the California red scale have given more accurate information on reproduction than has hitherto been available. The greatest number of young produced by a single female was 300. One scale produced young over a period of 287 days. Because of this long period of reproduction, the generations of the scale insect overlap to a considerable extent.

JAPANESE AND ASIATIC BEETLES

In the older areas of infestation the emergence of adult Japanese beetles began somewhat earlier in 1936 than in 1935 but did not reach a peak so quickly. There was a general increase of beetle abundance within the New York, N. Y., metropolitan area, and a continuance of large areas of severe injury in north-central New Jersey, eastern Pennsylvania, and, to a modified extent, in southwestern New Jersey, with the development of very serious injury in northern Delaware, northeastern Maryland, and extreme southeastern Pennsylvania. In southern New England the population showed a definite increase in 1936 as compared with 1935. There was, on the other hand, a general decrease in injury in the older infested area in the general vicinity of Philadelphia, perhaps in part due to severe mortality in certain localities during the winter of 1935–36.

As bait materials for the adult beetles, certain grades of Ceylon and Java citronella oil appeared to be more attractive to the beetles than the grade of geraniol used as a check bait. This held true in various types of traps and dispensers. Citronella oil is cheaper than geraniol and appears to be a satisfatory substitute attractant for the beetle.

Further improvements have been made in the rosin-residue emulsion as a sticker for use with derris, which is the most promising substitute for lead arsenate as a repellent for the beetle. Out of a large number of materials used with derris in an effort to decrease the rate of its decomposition by light or its removal by rains, those which caused the derris to be most persistent reduced at the same time its value as a repellent, with the exception of sulphur, which appeared to increase its value. Field experiments with derris and rosin-residue emulsion, and with lime and aluminum sulphate now recommended for the protection of early-ripening tree fruits, confirmed previous results and support existing recommendations.

Various materials have been tested to determine their influence on the effectiveness of lead arsenate in the control of larvae in the soil. The phosphates of sodium, potassium, or ammonium significantly increased the solubility of lead arsenate in the soil, and the phosphates of potassium and sodium also increased its insecticidal action when the lead arsenate was used at dosages of less than 1,000 pounds per acre, confirming results of the previous year. The phosphates of calcium, on the other hand, increased neither the solubility of the lead arsenate nor its toxicity to the grubs. The addition up to 10,000

pounds per acre of greensand marl, which is promising for use in soils to overcome or reduce arsenical injury to plants, did not significantly modify the insecticidal action of lead arsenate within 30 days after application. Further studies of the use of lead arsenate in various types of soil from different localities have shown that the character of the soil has a considerable influence on the effectiveness of the lead arsenate treatment, but that 1,500 pounds per acre, as at present recommended for nursery treatment, is adequate in most soils usually encountered. Some modification of recommendations for certain soils may, however, be necessary.

A large number of females of the imported hymenopterous parasite *Tiphia vernalis* Roh. have been collected in the field from well-established colonies and recolonized in other localities. During the early summer of 1937, 162 colonies, totaling 16,553 females, were placed in New Jersey, Pennsylvania, Delaware, Maryland, New York, and the New England States. With colonies that were established in 1933, parasitizations as high as 58 percent have been found. Among the imported parasites, this species appears to be by far the best adapted to the biology of the Japanese beetle.

The introduced parasite *Tiphia popilliavora* Roh. is well established in many localities, and during the summer of 1936 field-collected females to the number of 4,818 were recolonized at 44 points in New Jersey, Pennsylvania, and Delaware. It has been found that a number of adults of this species have not emerged until the second or third year following that in which the cocoons were formed. The form of *T. popilliavora* first introduced is, unfortunately, rather poorly synchronized with its host in the Moorestown, N. J., area. Special attention has therefore been given to a Korean strain of this parasite, which emerges later, at a time much more favorable to parasitization. During 1936 nine colonies of this strain were liberated in New Jersey and Pennsylvania.

Further studies have been made of the diseases attacking the immature stages of the Japanese and Asiatic beetles in the soil. Examinations in the field at frequent intervals during the season showed in the early spring a low percentage of diseased grubs; the proportion increased rapidly to a peak of 36 percent late in June. The disease rate fell rapidly as the new brood of larvae developed, then rose to a maximum of about 13 percent in September, and fell off again as cold weather came on. Observations on field plots in which types A and B milky diseases were artificially introduced in 1935 indicated the establishment of the disease with spring introductions, the disease rate increasing to as high as 44 percent by June 1936. Similar plots started in the fall of 1935 indicated that fall is not a satisfactory time for introducing a disease organism, because of falling temperatures and unfavorable weather conditions.

Material of *Tiphia sternata* Park, a parasite of the Asiatic garden beetle, was received from the Division of Foreign Parasite Introduction and increased in the laboratory for further colonization. Fourteen hundred adult females of this species were liberated at five centers in Pennsylvania and New Jersey. At least a few of this species passed the winter of 1936–37 successfully, as evidenced by the recovery at Palmyra, N. J. *T. asericae* A. and J. was likewise recovered in the spring of 1937.

In order to keep in touch with the progress of the Japanese beetle in the more recently infested areas and to determine its behavior under new conditions, as a basis for studies of control measures in connection with efforts to retard its spread, a new field laboratory has been established at Salisbury, N. C. For the present the work deals primarily with the biology, food plants, and behavior of the beetle under conditions in the outer zone of spread; this is to be followed as soon as feasible by experiments with the control of the insect under the new conditions.

FRUITFLY INVESTIGATIONS

The research work on fruitflies has been continued as in the past in the laboratories in Mexico City, Honolulu, Mayaguez, P. R., and the Canal Zone.

In Mexico work has been done on the sterilization of fruit by refrigeration to guarantee its freedom from living eggs and larvae of the Mexican fruitfly. Studies at 34° to 35° F. resulted in adults emerging after 16 days of exposure. Puparia were formed by larvae which had been exposed for 17 and for 18 days, but no adults emerged from these puparia. The results indicate that the

Mexican fruitfly is more resistant to low temperatures than are the other fruitflies so far studied.

The resistance of adults to low temperatures was studied with an instrument designed by W. E. Stone which permits the reproduction of a continuous temperature record taken in any locality. The exposure covered 6 days of cold weather during which the temperature ranged as low as 26.9° F. Only 30 percent of the young flies used were killed and the remainder subsequently infested fruit in a normal manner.

Spraying experiments with 4 pounds of tartar emetic and 20 pounds of granulated sugar in 100 gallons of water gave promising results in reducing the populations of the Mexican fruitfly, as high as 90 percent reduction being obtained in one instance. Sprayed grapefruit trees held their crop well on into June, whereas the entire crop fell from the unsprayed trees early in the season.

In Hawaii low-temperature sterilization experiments with fruits infested by the Mediterranean fruitfly were continued. At 33° F. no larvae were able to mature to adults after 10 days of exposure. At a temperature of 36.5° no adults were obtained after an exposure of 12 days. The early stages of the melonfly appeared more susceptible to low temperatures, since no adults were obtained at 36.5° after an exposure of 10 days. In the treating room there was a fluctuation of 1°, so that for short periods the larvae were held at slightly below 36°.

Studies were conducted with papayas to determine their susceptibility to attack by the melonfly. Both ripe and commercially picked papayas proved to be definitely susceptible.

Studies with screen barriers against the drift of melonflies into cucumber plots have shown a definite reduction in infestation. The barrier cost, however, has not been offset by the returns. More promising results from the monetary viewpoint were obtained with a nicotine spray.

Studies on holding fruits infested by the Mediterranean fruitfly in sealed containers showed that 100 percent mortality of the early stages of the insect can be obtained in this way, but effects of such treatment on sound fruits have not as yet been obtained.

In Puerto Rico studies on low-temperature sterilization of fruit infested by the two species of fruitflies *Anastrepha suspensa* Loew and *A. acidusa* Walk. have been continued. Work at 32° F. has shown that 11 days of exposure at this temperature will prevent the early stages from maturing to adults. Later studies at 34° F. gave complete mortality of the early stages after exposure of 13 days at this temperature. Studies at 36° F. were inaugurated and show that larvae exposed to this temperature for a period of 15 days are still able to form puparia. No adults, however, have so far been obtained after an exposure of 12 days.

Sterilization studies with the vapor-heat process, exposing fruits to 110° F. for 8 hours with an approach period of 8 hours before the temperature of 110° is reached, showed that the Puerto Rican species of fruitflies require a slightly longer period for a complete kill to be obtained by this method than does the Mediterranean fruitfly, since there were a few survivals after 8 hours.

MEXICAN FRUITFLY CONTROL

INFESTATIONS

Traps were used extensively on this project in Texas to determine the extent of the adult population of the Mexican fruitfly (*Anastrepha ludens* Loew). Few flies were taken before the first of the year. In January, however, it became apparent that there were many more flies in the area than during any previous season, and that if conditions remained favorable, larval infestations might become general. The number of flies recovered from traps continued to mount throughout February, but no infested fruit was found until toward the close of the month. Early in March the condition changed radically. Relatively few flies were trapped, but larval infestations were found in all districts. In April the fly population again mounted, and the number of larval infestations decreased. In May only a small amount of infested fruit was found during the tree-to-tree inspection work, and none was discovered in June. Throughout these 2 months the fly catch continued to decline to a point where only four flies were trapped the latter half of June.

The records of the infestation of *Anastrepha ludens* in the Rio Grande Valley suggest it may be the result of flies coming from Mexico during the winter months rather than a continuing permanent population in the area. If such a migratory movement occurred this season it evidently reached a peak during the first half of February, the incoming flies disappearing by the middle of March. The larger number of flies taken during April and May may have resulted from larval infestations in February and March.

Adult and larval infestations are shown by districts in table 1.

TABLE 1.—*Infestations of the Mexican fruitfly in Texas, fiscal year 1937*

District	Adults trapped		Larval infestations (premises)	District	Adults trapped		Larval infestations (premises)
	Specimens	Premises			Specimens	Premises	
Mission	404	43	221	Raymondville	8	4	2
McAllen	675	35	82	Harlingen	98	25	43
Edinburg	780	38	89	San Benito	110	30	38
Pharr-San Juan-Alamo	491	31	108	Brownsville	46	12	45
Donna	760	29	85	Falfurrias	75	10	9
Weslaco	592	36	136				
Mercedes	276	27	70	Total	4,714	349	1,062
La Feria	399	29	134				

OTHER SPECIES OF FRUITFLIES TRAPPED

Other species of *Anastrepha* and *Toxotrypana* are frequently taken in traps along with *A. ludens*. The host of one fly (*A. pallens* Coq.) is known; it is *Bumelia angustifolia*, a noneconomic sapotaceous plant. No local hosts for the other flies have been found, and it is believed that the occurrence of these flies in this area is likewise the result of a migratory tendency. Flies were taken throughout the area, as shown in table 2.

TABLE 2.—*Other fruitflies trapped in Texas, fiscal year 1937*

District	*Anastrepha serpentina*	*Anastrepha acidusa*	*Anastrepha pallens*	*Anastrepha* species *Y*	Other *Anastrepha* species	*Toxotrypana curvicauda*
Mission	6	5	382	20	2	22
McAllen	19	6	143	25	4	26
Edinburg	7	6	1,871	35	5	14
Pharr-San Juan-Alamo	15	11	311	26	0	8
Donna	13	15	182	28	4	21
Weslaco	35	11	486	29	5	15
Mercedes	7	3	277	10	0	8
La Feria	7	5	392	18	0	9
Raymondville	0	1	270	4	0	0
Harlingen	6	4	553	12	1	3
San Benito	9	7	209	7	2	3
Brownsville	1	0	179	5	0	1
Falfurrias	13	5	387	14	0	1
Total	138	79	5,642	233	23	131

GROVE AND PACKING-HOUSE INSPECTIONS

The purpose of grove inspections is twofold. Inspections are made to determine if the fruit is free from larval infestations and also to enforce the sanitary provisions of the quarantine regulations. This season the issuance of permits to harvest fruit was based upon the condition that the fallen fruit had been picked up and properly buried at weekly intervals. Packing houses are inspected regularly to enforce quarantine sanitary requirements and to check records of origin of fruit harvested and shipped.

The monthly summary of these inspections, together with certain information relative to trapping and the removal of alternate host-fruit trees, is shown in table 3.

TABLE 3.—*Field inspections in Texas, fiscal year 1937*

Month	Grove inspections	Premises trapped	Traps operated	Trap inspections made	Secondary host fruit	
					Trees destroyed	Premises cleaned
July	565	511	9,007	34,232	3	3
August	323	501	8,995	34,781	2	1
September	654	480	8,616	27,075	3	2
October	8,386	381	6,300	17,513	11	2
November	14,137	269	5,099	18,672	25	5
December	13,664	304	5,749	22,722	2	2
January	12,749	321	5,947	20,725	0	0
February	13,151	334	5,952	19,430	0	0
March	8,570	311	5,836	23,728	2	1
April	1,728	293	5,695	22,001	102	40
May	38	547	6,489	23,258	95	33
June	0	672	7,819	33,557	8	5
Total or average	73,965	394	6,792	297,694	253	92

ACTIVITIES IN MEXICO

Large quantities of various kinds of fruit are shipped regularly from the interior of Mexico to the border. Frequently part of this fruit is infested with fruitfly larvae. In preceding years larval infestations have developed in local hosts in the border towns. To reduce infestations in Mexico and prevent their spreading to Texas groves, one inspector and one laborer are stationed at Matamoros to collect infested fruit and operate traps. The success of this phase of the work is proved by the fact that in spite of the wormy fruit being sold there, no larval infestations have been detected in any fruit produced in Matamoros during the last 4 years. Traps are operated continuously, and whenever adults are taken, poison spray is applied to the trees.

Table 4 shows the number of adults and larvae taken in Mexico during the year.

TABLE 4.—*Adults of Anastrepha spp. trapped and larvae of the same collected in Mexico, fiscal year 1937*

Location	Adults trapped						Larvae collected in imported fruit			
	Anastrepha ludens	*Anastrepha serpentina*	*Anastrepha acidusa*	*Anastrepha striata*	*Anastrepha* species *Y*	*Anastrepha pallens*	*Anastrepha ludens*	*Anastrepha serpentina*	*Anastrepha acidusa*	*Anastrepha striata*
Matamoros	18	0	1	1	1	10	3,498	196	3,057	50
Reynosa	12	0	0	0	0	2	0	0	0	0
Reynosa brush	0	3	2	0	0	136	0	0	0	0
Total	30	3	3	1	1	148	3,498	196	3,057	50

ROAD TRAFFIC INSPECTION

Two road stations were operated on the main highways leading from the regulated area. The personnel of these stations inspected all vehicles and confiscated fruit moved in violation of quarantine regulations. The fruit passing these two stations approximated 5,000 carlots. Confiscations totaled 456 lots of fruit. In only a few cases did it appear that the drivers of vehicles from which this fruit was taken were attempting to violate quarantine regulations. In only one case were charges filed and a fine assessed.

SHIPMENT OF FRUIT

The commercial fruit produced in the Rio Grande Valley increased from 9,447 equivalent carlots for 1935–36 to 30,701 equivalent carlots for 1936–37. This increased production taxed the packing and shipping facilities of the industry as well as the inspection force on this project to certify it for ship-

ment. All regular means of transportation shared in the increase, and, in addition, 193 equivalent carlots were moved by steamer to seaboard markets. This is the first season that ocean transportation has been available from valley ports.

Table 5 shows the shipments of fruit from this area for the seasons 1932–33 to 1936–37.

TABLE 5.—*Equivalent carlot shipments of citrus fruit from the lower Rio Grande Valley, Tex., and total production in stated years*

Shipping season	By rail		By truck		By boat		By express and passenger car	Grapefruit canned	Commercial production
	Grapefruit	Oranges	Grapefruit	Oranges	Grapefruit	Oranges			
1932–33	2,897	230	880	586	--------	--------	101	127	4,821
1933–34	1,748	114	1,236	877	--------	--------	99	240	4,314
1934–35	4,617	225	1,731	1,095	--------	--------	239	1,131	9,038
1935–36	4,262	600	1,454	1,182	--------	--------	267	1,682	9,447
1936–37	15,616	2,729	2,578	2,351	176	17	532	6,702	30,701

CANNING PLANTS

The grapefruit canning industry consumed 25 percent of the grapefruit produced. This amounted to 6,702 equivalent carlots. Practically all the plants were equipped with steam sterilizers for sterilizing canning-plant debris. This equipment was designed by workers in the Bureau in order to kill any larvae that might have been in fruit sent to a cannery. The increase in the volume of fruit processed since 1932 is shown in table 5.

JAPANESE BEETLE QUARANTINE AND CONTROL

TRAP SCOUTING IN NONREGULATED TERRITORY

Trap scouting for the Japanese beetle was carried on during the summer of 1936 in 324 towns and cities in 19 States, an increase of 111 communities and 6 States over those trapped in the previous year's annual survey of nonregulated territory. Approximately 103,500 traps were set, doubling for the second consecutive year the number of traps set as compared with the previous summer's trapping program. This extensive survey was made possible by the use of 90,000 lightweight, collapsible traps, developed by project personnel and manufactured at the Bureau's warehouse in Pennsylvania. Savings of 75 percent in manufacturing cost, 80 percent in freight cost, and 25 percent in set-up and removal expense were effected by the use of these traps.

Results of trapping in 1936 disclosed 36 first-record infestations, 16 of which were in Maryland, 3 in West Virginia, 2 each in Georgia, Indiana, Kentucky, North Carolina, Ohio, and Virginia, and 1 each in Maine, Michigan, New York, Pennsylvania, and Tennessee. With exceptions of first-record infestations at Jessups, Millersville, New Market, Point of Rocks, and Riviera Beach, Md., Grafton and Hollidays Cove, W. Va., Sharon, Pa., and Brewer, Maine, all these initial finds involved fewer than 10 beetles each. Beetles were caught in 108 communities in which incipient infestations had been determined. Trapping in 183 cities and towns gave negative results.

Initial trapping in four localities in Tennessee resulted in the capture of four beetles at Bristol.

Capture of one beetle each in Augusta and Savannah was the net result of trapping resumed in Georgia after a lapse of 4 years.

In Greenville, S. C., trapping revealed a reduction from 89 beetles in 1935 to 33 beetles in 1936. All but one of these appeared in the area where delayed applications of lead arsenate were made in the spring of 1936. In Charleston, S. C., where trapping was with negative results in 1935, 11 beetles were caught. These were scattered in the southeastern section of the city near the water front and freight terminals, a section in which lead arsenate was applied in 1931. None of the 1936 finds were in the blocks previously treated.

Traps set in 35 communities in North Carolina revealed infestations in 15 localities. Small infestations failed to reappear in seven towns. The catch at Winston-Salem showed a reduction from 109 beetles in 1935 to 37 beetles this

season. Initial finds of one beetle each were made at Elizabeth City and Wilson.

This season's trapping in Kentucky was the first undertaken in that State. Five cities were trapped. Two beetles in Louisville and one in Lexington were the net results of trapping in the State.

Beetles were caught in 9 of the 10 communities trapped in West Virginia; Fairmont, Parkersburg, Clarksburg, and Chester, all under a State quarantine since April 15, 1936, had the most substantial increase. Catches paralleling those of last year were made at Huntington, Martinsburg, Princeton, and Wheeling. One beetle was trapped for a first record at Charleston. Reported infestations at Grafton and Hollidays Cove were confirmed by hand collections.

Extensively scattered trapping throughout the nonregulated sections of Maryland turned up 16 first-record infestations, the most important being at Jessups, Millersville, New Market, and Riviera Beach. Carry-over infestations were disclosed at eight other points.

Trapping at Erie, Pa., revealed a still further reduction in catches for the fourth consecutive year. Only a small percentage of the 45 beetles caught came came from the previously treated area. A first record at Sharon and an increase to 15 beetles at Warren, where 1 beetle was caught in 1933, were the net results of trapping at 9 communities in northwestern Pennsylvania.

An increased number of traps in Cleveland, Ohio, netted 1,193 beetles as compared to 13 caught in 1935. Small infestations at four other Ohio points failed to reappear. However, there were uniform increases in 11 cities, those of largest proportion being in Cleveland, Youngstown, Hills and Dales, Steubenville, Toledo, Marietta, and East Liverpool. The catch at Cleveland was concentrated chiefly on the east side some distance from the network of railroads bordering the Cuyahoga River; that at Youngstown was concentrated in a limited section near fields favorable to larval development; that at Steubenville, between the Ohio River and the railroad yards; and that of East Liverpool in the vicinity of railroad terminals. First-record infestations of seven beetles each were found at Gallipolis and Mansfield. Approximately half the expense of trapping the 35 communities in Ohio was borne by State authorities.

Collections at Buffalo, N. Y., with a 400-percent increase in the number of traps set, mounted to 214 against 47 for 1935. Practically all of the beetles were caught in the southeastern section of the city, in the vicinity of freight yards. Some 60 percent were caught within a radius of 1½ miles of the Food Terminal and Farmer's Market. All of the infestations discovered last year persisted. One beetle was caught at Lockport for a first record. The catch at Rochester, double that of 1935, was concentrated near the New York Central Railroad yard. Fourteen cities were trapped this year.

Trapping resumed in Vermont after a 3-year lapse revealed a sizeable infestation at Burlington and negative results in three other cities. No beetles were caught in three cities trapped in New Hampshire. Of the 19 cities and towns trapped in the nonregulated area of Maine, only Brewer disclosed an infestation.

There was a 50-percent reduction over last year in the number of beetles caught in Indianapolis, Ind., with only one beetle picked up in the area previously treated. Small initial finds were reported at Fort Wayne and South Bend, Ind. Ten cities were trapped in Indiana in 1936.

From captures of 6 beetles in 1934 and 39 last year, this season's catches in Chicago increased to 3,740 beetles, more or less segregated in 6 rather widely separated infestation centers. Trapping in Chicago this year was much more extensive than in either of the 2 previous years. Some 7,500 traps were systematically distributed in all sections of the city likely to contain infestations. Traps were concentrated in sections showing infestation in 1935 and in sections untrapped last year. As infestations were turned up in sections affording desirable soil conditions for beetle survival, additional traps were concentrated at these points. At the end of this season, a fairly complete picture of the Chicago infestation centers and degrees of infestation was available. A negligible infestation persisted in East St. Louis, Ill. Trapping in five additional Illinois cities was with negative results.

This year 128 beetles were caught in Detroit, Mich., as contrasted with successive years' catches, starting in 1932, of 8, 4, 10, and 23 beetles, respectively. The use of 4,500 traps permitted coverage of practically all sections of the city. Over half of this year's collections were taken in the southwestern sections of the city in the vicinity of the Detroit Railroad produce terminal.

There were six other scattered locations where beetles were caught in numbers, and a scattering of single catches. Dearborn reported a one-beetle first-record infestation. Results in five other Michigan cities were negative.

There was a drastic reduction in the infestation at St. Louis, Mo. Whereas 1,351 beetles were caught in 1934, and 1,232 in 1935, this year's catch was reduced to 88 beetles. Of this total, only 14 came from the extensive area treated in 1934 and 9 of these came from two adjoining blocks in the center of the treated area. This amounts to a 99-percent reduction in beetle population in treated sections. In blocks treated for the first time in 1935, the catches totaled 59 beetles in 4 blocks. This represents a reduction of approximately 85 percent. Most of the 15 remaining beetles were taken in blocks contiguous to previously treated areas. As fast as beetles were trapped this year in unpoisoned sections, lead arsenate was applied. No beetles were caught in traps distributed in five other Missouri communities.

Traps were operated in four Kansas cities this year with negative results. Placement of traps in this State was largely occasioned by the erroneous report of the finding of a Japanese beetle near Manhattan early in May.

Early-season trapping activities in 1937 began with the placement of traps in Miami, Fla., on April 21. Trapping was completed before the end of the fiscal year in Mobile, Ala., in five cities in Florida, in two localities in Georgia, in New Orleans, La., and in two nonregulated communities in South Carolina. At the end of the year traps were in operation in 231 cities and towns in 16 States.

Trap captures recorded during May and June 1937 included 1 beetle at Atlanta, Ga.; 160 beetles at Greensboro; 126 at Winston-Salem; 36 at Spencer; 35 at East Spencer, and small captures at five other communities in North Carolina; 8 at Marietta and 3 at Gallipolis, Ohio; 7 at Charlottesvile, Va.; and 2 at Charleston, S. C. The find at Atlanta, Ga., was a first record; the others were survivals of previously determined infestations. A first-record collection of 750 beetles at the George Washington Birthplace National Monument at Wakefield, Va., was reported on June 19.

SUPPRESSIVE MEASURES

With the extent of the Chicago infestations as well defined as could be accomplished in one season, the Illinois officials were in a position to inaugurate a control program in the city. Approximately 130 acres were sprayed with lead arsenate at the usual dosage of 1,000 pounds per acre. Treatment of 95 acres was accomplished between August 24 and November 16, 1936. Operations were resumed on May 6, 1937, and treating of the remaining 35 acres was accomplished by June 11. Lead arsenate and labor for its application were supplied from a $17,000 State fund. This Bureau furnished a supervisor, two sprayers and operators. Two spray outfits borrowed from the Chicago Park Department were utilized. Illinois State officials and Chicago municipal officials cooperated fully in this control work. In addition the State maintains an intrastate quarantine to restrict the movement of host plants from infested sections. This quarantine was revised effective February 1, 1937, to add the additional infestations disclosed by the 1936 trapping.

At the conclusion of the seasons' trapping in Detroit, Mich., treatment of 118 acres was begun. The Works Progress Administration, State, and city, furnished all items except supervision, which was furnished by this Bureau. Between October 6 and November 6, 1936, lead arsenate was sprayed on 48 acres; the remaining 70 acres were treated between April 6 and May 21, 1937. Soil insecticide application in Detroit extended to all infested sections in the southeastern part of the city, to those blocks in which more than one beetle was found, and to most of the single-beetle finds.

In St. Louis, Mo., 61 acres were treated; 26 of these were in the infestation areas of 1934 and 1935. The dosage was reduced to 500 pounds per acre on two adjoining blocks in the center of an area treated in 1934. In addition, 13 acres in scattered locations in the area sprayed in 1934 were re-treated at normal dosage. As fast as beetles were trapped this year in unpoisoned sections, lead arsenate was applied. The Federal Bureau, the State of Missouri, the city of St. Louis, and the Works Progress Administration cooperated in this program. The Bureau furnished two high-pressure sprayers, one operator, and a general supervisor. The State furnished a foreman to assist in the work and sponsored the W. P. A. project through which the lead arsenate and labor were secured. Incidental supplies were furnished by the city.

Ten tons of State-purchased lead arsenate were applied to 20 acres of newly infested areas at Erie, Pa., between April 29 and May 12, 1937. The project, for which two Federal-owned sprayers were provided, was manned by labor paid from State funds.

Funds for labor and 22 tons of lead arsenate for a soil-treatment program at Cleveland and Marietta, Ohio, were provided by a State appropriation of $32,500. At Cleveland 23 acres were treated between May 17 and June 8, 1937. In Marietta 17 acres were sprayed between April 15 and April 24, 1937. Federal equipment was used.

At Indianapolis, Ind., the treating program began April 22 and was completed May 24, 1937. State-purchased lead arsenate was applied to 21 acres. The Federal Bureau paid for the operators and supervision and supplied two spray outfits.

FEDERAL AND STATE REGULATORY MEASURES

Revised regulations were issued, effective March 1, 1937, to extend the restricted zone. In Ohio, the infested cities of Cleveland, Columbus, Steubenville, and Toledo, all of Columbiana and Mahoning Counties, and scattered townships in Carroll, Jefferson, and Stark Counties were placed under Federal regulation. Brewer, Maine; points in Anne Arundel, Baltimore, and Frederick Counties, Md.; an area in Erie County, N. Y., including Buffalo, Lackawanna, and three surrounding townships; and Burlington, Vt., were included in the restricted zone as isolated areas. Other extensions of the regulated area include districts in Chesterfield and Princess Anne Counties, Va.; also the counties of Hancock, Harrison, Marion, Monongalia, and Taylor, and the city of Parkersburg in Wood County, W. Va.

This revision further required the certification of fruits and vegetables when shipped during the period June 15 to October 15, inclusive, from other portions of the regulated zone to isolated areas at Brewer and Waterville, Maine; Buffalo, N. Y., or to the other regulated parts of Erie County, N. Y.; Cleveland, Columbus, and Toledo, Ohio; Burlington, Vt.; and Parkersburg, W. Va. No restrictions, however, were placed on the movement of any fruits or vegetables from these outlying portions of the regulated area.

An amendment to the regulations, effective May 10, 1937, added to the territory from which the movement by refrigerator car or motortruck of fruits and vegetables is restricted the counties of Kent, Queen Annes, Somerset, and Worcester, most of Caroline County, 1 point in Dorchester County, and 10 districts in Wicomico County, Md.; and also Accomac and Northampton Counties, Va. Under a proviso in this amendment the area designated as heavily infested may be extended or reduced by the Chief of the Bureau when in his judgment such action is considered advisable.

Supplementary intrastate quarantines issued by Ohio and West Virginia placed under regulation the newly federally regulated areas in these States.

Incipient infestations in Georgia, Kentucky, and Tennessee, and in the nonregulated portion of Pennsylvania were not of sufficient importance to justify quarantine action. The situation in North Carolina was adequately handled by continued enforcement of an intrastate quarantine extending to all important isolated infestations in the State. A North Carolina inspector devoted his entire time to enforcement of the State regulations. Chemical treatment of isolated infestations to avoid Federal quarantine action was employed in Illinois, Indiana, Michigan, Missouri, and South Carolina.

HIGHWAY INSPECTION SERVICE

During July, with road movements of quarantined products at a peak, 24 stations were added to those already in operation at the beginning of the fiscal year. Forty roads were posted by August 1, of which number 1 was in Maryland, 5 were in New York, 2 in Ohio, 12 in Pennsylvania, 12 in Virginia, and 8 in West Virginia. At the peak of the work 64 road inspectors were employed.

Closing of the regular stations began late in August, and gradual abandonment of the posts continued during October and November. By the end of November the only remaining station was that on U. S. Route 1, south of Fredericksburg, Va. This station operated 16 hours a day during December. No year-round stations were kept in operation.

Organization of the road-patrol activities in the spring of 1937 began with the posting, during the last 2 weeks in March, of five road stations to handle southbound traffic from the slightly enlarged Virginia regulated zone and two

road stations on the Maryland-Virginia State line. The extension of the regulated area to parts of Ohio made it necessary to establish six new posts on as many highways in that State. Between April 18 and 30, 14 posts were established in Pennsylvania and West Virginia in addition to those in Ohio, most of them with one inspector each, operating 8 hours per day. This concluded the posting of the most important highways.

When the seasonal restrictions on fruits and vegetables became operative on June 15, four additional stations were opened in Virginia. Inspection personnel was increased during June and full quotas of men were assigned to the posts by June 30.

At the end of the fiscal year there were in operation 32 road stations, 2 of which were on the Maryland-West Virginia State line, 6 in Ohio, 11 in Pennsylvania, 9 in Virginia, and 4 in West Virginia. A maximum of 60 inspectors were engaged in road inspection during the spring season.

Trucks returning empty to southern points after driving through sections in which beetles were swarming were again found to contain large numbers of living beetles. A total of 1,492 beetles were taken from 250 trucks. Finds ranging from 20 to 66 beetles were common. Seventy lots of infested plant material were intercepted at the posts, from which were taken 120 adults and 56 grubs.

Counts of all motor vehicles stopped for inspection at the road stations during the year totaled 3,919,286. Uncertified quarantined products were found in 20,355 vehicles.

CERTIFICATION AND TREATMENT OF NURSERY STOCK

Continued beetle population build-up in the metropolitan area of New York City was again responsible for additions to the number of nurseries and greenhouses found to be infested with the Japanese beetle. Few important commercial establishments in this area maintaining classified status under the quarantine regulations remained uninfested by the time the nursery and greenhouse scouts were dismissed late in August. Observations by scouts engaged in the survey of classified premises showed that unfavorable environmental conditions during the winter of 1935–36 caused a heavy grub mortality in the older infested area. This resulted in a decided decrease this summer in the number of Japanese beetles present in the Philadelphia area. The water-front district was practically free from flying beetles, and they were also scarce in parks and public squares nearest the markets. This condition was noted in Camden and Philadelphia suburban areas. In Delaware, sections of southwestern Pennsylvania, north-central New Jersey, and the metropolitan sections of New York City there were heavy concentrations of beetles. Windrows of beetles that had flown to sea and were washed back by the tides were again observed on the ocean beaches of northern New Jersey, Staten Island, and Long Island. There were definite increases in the beetle infestation throughout the bean-growing section of Maryland and the Eastern Shore of Virginia.

Many new infestations were found during 1936 in nursery and greenhouse premises in northern New Jersey and Virginia. A total of 23 nursery and greenhouse establishments were infested in the New England sector. No classified nurseries were found infested in West Virginia or the Eastern Shore of Virginia. The last of the nursery and greenhouse scouts were dismissed on September 19.

There were no new developments in the procedure for the sterilization and fumigation of nursery stock, other than the formal approval of the paradichlorobenzene treatment of certain varieties of azaleas. This type of treatment was also tried with some measure of success on other varieties of plants to determine the effect of the fumigant on survival of the plants.

Owing to the extremely dry weather there was little movement of nursery stock in September. In general, however, shipments were heavier this year. Throughout the regulated area there was an increase in the number of shipments of nursery stock during February over those in the same month for the past several years. Extremely mild weather reported in most sections as early as January stimulated the nursery trade to much above average. Nurseries were able to ship almost continuously throughout the winter.

By March temporary inspectors were required at several points to meet the demands of the increased nursery activities. At Trenton, where 1 nursery reported 13 carload shipments for the month, 6 temporary inspectors were added. Spring shipments of nursery stock were not completed this year until

the end of June. Many greenhouses reported the largest volume of business since 1929.

About 1,000 samples collected from 97.7 acres of nursery plots, heeling-in areas, and frames treated with lead arsenate were analyzed by the Division of Insecticide Investigations to determine the concentration of the poison in the soil. Application of the poison to areas showing dosages less than the required amount was completed by June 30. Initial applications of lead arsenate were made to 10.8 acres of nursery plots and heeling-in sections.

Commercial establishments conforming to the requirements for classification increased from 2,271 to 2,365. Divided on the basis of classification, 1,721 of these establishments were in class I, 624 in class III, and 20 in an intermediary classification. The number of uninfested classified nurseries increased by 85. Many classified establishments dropped their classification upon the finding of an infestation on their premises. There was a net increase of nine in the number of infested classified establishments.

Emergence of adult Japanese beetles was reported as early as May 13 from Holmes, Pa. Adult beetles were also discovered on May 15, at Norwood, Pa.

CERTIFICATION OF FRUITS, VEGETABLES, AND CUT FLOWERS

Demands for the inspection of fruits and vegetables during the 1936 period of adult beetle flight were met by a corps of 138 inspectors. Thirty inspection centers were established throughout the regulated area: One each in Connecticut, the District of Columbia, and Maine; two each in Massachusetts and Pennsylvania; three in Virginia; four each in New Jersey and Maryland; five in Delaware; and seven in New York.

Fumigation of refrigerator cars was required on a larger scale than ever before. For the second season inspection of all southbound fruits and vegetables was concentrated at Fredericksburg, Va. This was for the purpose of eliminating the possibility of reinfestation of certified produce traveling through the flight area. By centralizing this work at Fredericksburg it was possible to reduce the force to the minimum in southern New Jersey, eastern Pennsylvania, and Maryland. An administrative order, effective June 1, 1936, exempted from the quarantine restrictions certain articles that theretofore had required inspection and thus relieved shippers and inspectors of considerable routine work in connection with the certification of noncarriers of the Japanese beetle.

Inspection of freight cars destined to or reconsigned from Chicago, Cincinnati, Kansas City, Milwaukee, and St. Paul netted about 200 live beetles. About 75 percent of them were taken from refrigerator cars of produce from the Eastern Shore. The living beetles probably gained entrance to the cars through hatch screens that were sometimes broken by falling cinders or in connection with reicing. Heavier screens, wired in, were prescribed as soon as this situation came to the Bureau's attention.

The quantity of farm products certified in New Jersey was more than three times as great as in the summer of 1935. Owing to the decrease in the number of beetles and conditions in general at the time, requirements for the fumigation of refrigerator cars for potato shipments and screening of cars were lifted on September 10.

Large quantities of beans offered for inspection in Maryland and Virginia areas necessitated the use of 11 bean machines and 12 additional inspectors.

The seasonal restrictions on fruits and vegetables were removed September 21. The restrictions on the movements of cut flowers continued in effect, however, until October 15.

In the course of the seasonal quarantine on fruits, vegetables, and cut flowers, inspectors removed 2,218 adult beetles from 6,150,311 packages of commodities certified for transportation to uninfested States. The articles from which the greatest numbers of beetles were removed were beans, cut flowers, corn, and potatoes.

CERTIFICATES ISSUED, VIOLATIONS INVESTIGATED, AND PROSECUTIONS TERMINATED

During the year 365,035 certificates of all kinds were required to cover quarantined products moving to nonregulated territory.

Table 6 shows the quarantined articles intended for shipments from the regulated area and for use in certified greenhouses or surface soil plots, in heeling-in areas, or in plunging areas, which were fumigated or sterilized during the 12-month period.

TABLE 6.—*Materials fumigated or sterilized under Japanese beetle quarantine regulations, fiscal year 1937*

Treatment	Plants	Potting soil	Sand		Surface soil	Surface soil with plants	Berries	Potatoes	
	Number	*Cubic yards*	*Cars*	*Cubic yards*	*Square feet*	*Square feet*	*Crates*	*Cars*	*Bushels*
Lead arsenate	103, 488				136, 330	1, 232, 146			
Carbon disulphide gas or emulsion	7, 314	2, 850	76	1, 224	54, 167		6, 032		
Naphthalene		81			53, 434				
Steam		561							
Hydrocyanic acid								630	609
Paradichlorobenzene	50, 732								

	Tomatoes		Peppers		Onions	Egg plant	Empty cars	Mixed shipments	
	Cars	*Baskets*	*Cars*	*Bushels*	*Cars*	*Bushels*	*Number*	*Cars*	*Bushels*
Hydrocyanic acid	4	3, 441	3	3, 923	31	1, 119	7, 452	32	298

Nursery and ornamental stock, sand, soil, earth, peat, compost, and manure were certified for shipment from the regulated areas during the year in the following quantities:

Plants	number	47, 565, 188
Sand, earth, and clay	carloads	7, 931
Peat	do	7
Manure and compost	do	109

Fruits, vegetables, moss, and cut flowers certified during the seasonal quarantine on these articles were as follows:

Fruits and vegetables	packages	6, 101, 010
Moss	bales	6
Cut flowers	packages	49, 301

A total of 1,810 apparent violations of the Japanese beetle regulations were investigated by the Bureau. Convictions were secured for two violations; one a trucker transporting string beans from Norfolk, Va., to Morristown, Tenn.; the other a floral company which shipped palms and ivy plants from New York, N. Y., to Miami, Fla.

COOPERATIVE ENTERPRISES

Funds partially or wholly covering the cost of labor and equipment for the trapping programs within their respective States were contributed by Georgia, Illinois, Indiana, Kansas, Maine, Missouri, New York, North Carolina, Ohio, Pennsylvania, and West Virginia. The city of St. Louis, Mo., also contributed funds for the trapping program. Labor for the program was provided in St. Louis, Mo., and in Detroit, Mich., by the W. P. A. The National Youth Administration provided the manpower for the trapping program at Erie, Pa. The total contributions from Federal welfare, State, and city agencies for labor and materials used to set and remove traps were approximately $34,000. Cooperative control or quarantine activities in the regulated areas again received State funds from Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island, and Virginia.

Bureau cooperation in the experiments to determine the effectiveness of the nematode *Neoaplactana glaseri* in eradicating established infestations of the Japanese beetle is being continued at the State laboratory at White Horse under the agreement reached last year with the New Jersey Department of Agriculture.

PHONY PEACH DISEASE CONTROL

Under the expanded program of inspection conducted cooperatively with the plant-pest control officials of the States concerned, and augmented by allotments from the emergency relief appropriations, intensive inspection for the phony peach disease was made during the 1936 field season in the 11 known infected States, and a survey was conducted in 9 other peach-producing States. Approximately

150 Federal and 50 State inspectors were employed. This work, carried on in more than 550 counties, covered the region from Texas, Oklahoma, and Missouri, east to the Atlantic, south to the Gulf, and north to Pennsylvania and New Jersey. This activity has, it is believed, rather accurately delineated the infected localities in the eastern part of the United States. The disease was found for the first time in Pennsylvania and Indiana, in one county each. Nursery areas were given first attention, as heretofore; the number of nurseries receiving environs inspection was more than twice that of any previous year. Of the 425 nurseries inspected in the infected States, 104 were found exposed, and the diseased trees on neighboring properties were promptly removed from the vicinity of all nurseries except one. Mandatory orders have now been issued by several States requiring the prompt removal of any trees infected with the phony peach disease.

Nearly 13,000,000 peach trees in commercial plantings and home orchards were inspected; 140,844 trees infected with the disease have been removed from 6,633 properties. To protect accomplishments to date, follow-up inspection on all known diseased properties is under way in the 1937 field season.

The emergency relief project begun in 1935 was continued and has accomplished the removal of over 64,000,000 diseased, abandoned, and escaped peach trees from 11 infected States. The project was reduced 65 percent at the close of the fiscal year, having nearly accomplished its purpose in five States.

Control work has progressed to the point where the disease is being pushed back from the outer rim toward the center of infection and the intensity reduced at the center. Affected States are cooperating by furnishing men or funds, or both, and standardized State quarantines are in effect which provide for shipping only stock produced in disease-free environs.

Field headquarters for the project were moved in March 1937 from Atlanta, Ga., to Little Rock, Ark.

CONTROL OF PEACH MOSAIC DISEASE

Activities of the Department to eradicate the virus disease of peach trees known as peach mosaic have resulted, since the project was started as a cooperative Federal-State activity in 1935, in materially reducing the intensity of infection in many of the affected commercial peach-growing areas. The results of the program in Colorado and Utah are particularly significant. In Utah all known infected trees have been removed. In Colorado approximately 3,000 infected trees were found and destroyed during the 1937 spring inspection. This is less than one-third the number found last year, and approximately one-ninth that of the previous year. This marked reduction of the disease in this area, which appears to be approaching commercial control, has restored the confidence of the peach growers of the State, as indicated by their carrying on an extensive replanting program.

Control work was also carried on during the year in Arizona, California, New Mexico, and Texas. Extensive surveys were conducted in the six infected States, as well as all States bordering thereon, with the result that the disease was found for the first time in Oklahoma. One diseased tree, which had been shipped from an infected area, was found in Indiana, but no local spread was reported.

Since the control program was started in 1935, approximately 36,000 diseased trees have been removed and over 6,750,000 trees have been inspected. During the year 27,486 infected trees were removed and nearly 3,600,000 trees were inspected for the disease. This work has been carried on under allotments from emergency relief appropriation acts in close cooperation with plant-pest control officials of the affected States.

A public hearing to consider the advisability of establishing a Federal quarantine, held August 19, 1936, resulted in the decision that, for the present at least, State regulatory action would suffice to prevent the spread of peach mosaic. Uniform State quarantines are in effect.

CITRUS CANKER ERADICATION

The campaign of eradication of the citrus canker disease conducted throughout the citrus-growing areas of Texas and Louisiana, which was expanded and stimulated in 1935 and 1936 by allotments from the emergency relief appropriations supplementing regular appropriations, and by State funds, was continued on a similar intensive scale in 1937. In the 2-year period since the relief allotments have been made available, 58 counties and parishes in these 2

States have been inspected, many of them repeatedly, and it is believed that all infected areas have been located. Citrus canker was found in August 1936 on 3 properties in Texas not heretofore known to be infected, and 2 in Louisiana in the fiscal year, as compared with 9 new cases in these States in 1936 and 45 in 1935. These recent findings were on old infection areas, with the exception of one which was located on an uninhabited island in a Louisiana marsh. This island was inaccessible by boat, and the canker would no doubt have existed indefinitely except for the autogiro survey which was conducted in the Louisiana-Texas area in the spring of 1936. Recurring infections found in the Texas counties of Galveston, Brazoria, and Harris in the winter of 1936–37 were promptly removed. These involved several hundred young seedlings on properties from which diseased trees were eradicated during the past 2 years. No canker could be found on repeated inspections in the Beaumont, Tex., areas where an old infection center was located in the winter of 1935–36. No canker could be found in Texas south of the Galveston-Brazoria area.

Owing to the existence of citrus canker in Alabama and Mississippi in former years, and because of a heavy growth of wild and abandoned *Citrus trifoliata* trees in these States, a thorough survey was made in Mississippi during the year, and is under way in Alabama and that part of western Florida adjacent to the Alabama border. No citrus canker has been found in any of these States as a result of this survey.

The year's work has represented the inspection of 59,000 properties in 61 counties in 5 States.

Millions of escaped *Citrus trifoliata* growing in dense junglelike swamps and woodlands, or in abandoned nurseries, have been destroyed in the noncommercial areas of these five States, thus removing the medium through which citrus canker might eventually reach the commercial areas. Such eradication has been accomplished on a very large proportion of all citrus-growing properties in the infected areas of Texas and Louisiana. Since the beginning of the project in August 1935 nearly 21,000,000 such trees have been destroyed by relief labor, representing approximately 45 man-years of employment.

INSECTS AFFECTING FOREST AND SHADE TREES

ADVICE AND COOPERATION IN THE CONTROL OF FOREST INSECTS

Federal and State agencies administering forest lands, and private timber owners, look to the Bureau for information on the status of forest-insect infestations and for advice regarding the need of control and the methods to be used. As in past years, much time and effort of the Division of Forest Insect Investigations have been devoted to making surveys to locate and define areas where infestations occur, and preparing recommendations for control, including plans for work and estimates of the cost. These activities are of a service nature and are carried out in close cooperation with Federal organizations administering timbered lands, such as the Forest Service, National Park Service, and Bureau of Indian Affairs, and through them with the C. C. C. Similar cooperation also extended to State agencies and in some cases to private timber owners or associations. The land-managing units are responsible for administering and carrying out the control operations, although in most cases the technical direction and leadership of the work are supplied by the Bureau.

Most of this work has been concerned with various tree-killing bark beetles and has been carried out in the forested areas of the West from the field laboratories at Fort Collins, Colo., Coeur d'Alene, Idaho, Portland, Oreg., and Berkeley, Calif. In these cooperative activities more than 6,000,000 acres of forest was examined last year for bark beetle infestation. In addition to numerous recommendations made verbally or by letter, 83 reports presenting data and recommendations as to the status and need for control on forested areas were prepared and submitted to land-managing units. Fifty-one, or about two-thirds, of these reports were submitted to the Forest Service, 11 to the Park Service, 1 to the Indian Service, and 20 to private owners or organizations. These special reports dealt with the status of insects and involved consideration of a wide variety of conditions, and not all of them recommended that control work be undertaken. Following recommendations included in the reports, the land-managing units carried out recommended control work on approximately 750,000 acres.

For the first time in many years the eastern spruce beetle reached outbreak proportions in several areas in New England and New York. On the recommendation of the Bureau the land-managing agencies have work under way to control this outbreak on some 22,000 acres in the Green Mountain National Forest and adjacent privately owned lands.

On the advice and under the technical supervision of the Bureau, the Forest Service is continuing the effort to control the outbreak of the forest tent caterpillar in recreational areas in the Lake States.

RESEARCH ACTIVITIES

EFFECTS OF CLIMATE ON BARK BEETLES

Following the purchase of new low-temperature equipment at three of our western stations, the laboratory study of the effects of extreme cold upon the brood of pine bark beetles was considerably expanded. Pertinent facts so far established may be stated as follows: (1) Of the three most destructive western bark beetles the brood of the western pine beetle is least resistant to low temperatures, that of the Black Hills beetle is most resistant, while that of the mountain pine beetle is intermediate. (2) A species occurring in warmer parts of its range is less resistant to low temperatures than the same species in colder areas. (3) Bark beetle brood is less resistant to unseasonably low temperatures in the fall and early in the spring than to similar temperatures during the dead of winter, because of an establishment of "cold hardiness." (4) There are strong indications that individuals of the same species of bark beetle reared in the same area vary considerably as regards resistance to low temperatures according to the host tree in which they occur. (5) Some work upon the relation of the water and the lipoid contents of the body to cold hardiness has been begun but has not yet reached definite conclusions.

Something of the relation of drought periods and outbreaks of the western pine beetle has been known for some time. The frequency of drought periods in the Pacific Northwest has been studied through an analysis of tree rings and growth fluctuations covering the last 650 years.

PENETRATING OIL FOR CONTROL OF BARK BEETLES

For several years experiments with the use of penetrating oils in the control of bark beetles in sugar pine and ponderosa pine were conducted in California with more or less erratic results due to the thickness of the bark in these trees. However, the results were so excellent, where penetration was obtained, that it was decided to move these experiments to Coeur d'Alene and try the method out on bark beetles in the thinner barked lodgepole pine. The use of this method permits control work to proceed during seasons of high fire hazard. Definite progress has been made, but considerable experimental work is still needed to determine what factors, such as temperature, moisture content of bark, etc., are conducive to success.

INJECTION OF CHEMICALS INTO TREES

Experiments with the introduction of chemicals into the sap stream of trees was begun as a promising method of controlling bark beetles. The early work was done largely at Asheville, N. C. It has been applied on a fairly large scale in several experimental control operations in the northern Rocky Mountains and has proved very successful in trees which have not been infested so long that the water conduction has been seriously affected by the development of the blue stain fungus.

Living trees can also be injected with copper sulphate or other preservatives, which kill the tree and prevent later insect attack. Such material can then be used in rustic work or otherwise without injury from insect attack. Tree injection has been put to another use in the eradication campaign against the Dutch elm disease, where a modification of the method is used to kill elm trees and render them unsuitable for the attack and development of bark beetles which act as vectors of the disease organism.

WHITE GRUBS IN NURSERIES AND PLANTATIONS

Further investigations upon methods of treating the soil in forest nurseries so as to prevent later infestation have shown that all methods thus far tried

have either not prevented infestation or have been destructive to the seedlings as well. Poisoning the foliage of nearby host plants in order to kill the adult insects does not appreciably decrease the leaf chafer population. However, many tests indicate strongly that heavy populations of grubs may be adequately controlled by proper applications of carbon disulphide to the infested soil.

In the case of plantations, observations over several years have proved that a heavy population of white grubs in the sod prevents the successful establishment of a plantation. This can best be determined by actual sampling of the proposed plantation site. Losses in plantations can be reduced by avoiding areas that are heavily infested or by using wide deep furrows in which to plant in such areas. Indications are strong that grub abundance in a given area is controlled by the presence of suitable host trees and shrubs for the adult beetles. It is believed, therefore, that white grub populations in nurseries can be reduced by avoiding the use of these more favored host plants as hedges or ornamental plantings around such nurseries and by destroying as much as possible of such material as occurs naturally in or near the nurseries.

INSECTS AND THE DUTCH ELM DISEASE

Work upon insect carriers of the Dutch elm disease was continued both at Morristown, N. J., and at Oxford, England. The work at Morristown had previously established beyond doubt that the smaller European elm bark beetle is a frequent vector, but it is also now known that the native elm bark beetle can and does perform the same function. In the former case the young beetles' habit of feeding in the crotches of twigs makes it an effective vector. In the case of the native elm bark beetle the young adults emerging in the fall often bore into the bark of living elm trees and there pass the winter. Their burrows are often extended entirely through the bark to the xylem, and if such beetles are contaminated with the fungus, the disease often develops and kills the tree. In infected areas such as those in Cleveland, Ohio, and Indianapolis, Ind., where no European elm bark beetles are known to occur, the native beetle is almost certainly the vector.

During the year more than 10,000 insects were collected from felled elm trees put down at various points in the badly infected area of New Jersey. These insects were carefully collected in individual capsules and later cultured for the presence of the Dutch elm disease fungus. Many species of insects were collected, but of these only six were contaminated with the disease. These are *Scolytus multistriatus* Marsh., *Hylurgopinus rufipes* Eichh., *Magdalis armicollis* Say, *Xylosandrus germanus* Bldfd., *Xylobiops basilare* Say, and *Conotrachelus analglypticus* Say. Of these only the first two showed contamination in any significant percentage of the numbers cultured.

PINE SCALE INSECTS

Both in the West and in several points in the East a blighted condition of the twigs of several species of pines has been found associated with infestations of different species of *Matsucoccus*. In the Prescott National Forest and at other localities in the Southwest the association of these scales with the Prescott twig blight has been so close as to suggest that the scale insect may be an important factor. An intensive study, both on the Prescott form and on an eastern species affecting pitch pine, has been begun and will be continued on Emergency Conservation Work funds.

SPRAYING EXPERIMENTS

Considerable progress was made in developing concentrated mixtures of many of the well known insecticides used in insect control. These concentrated mixtures adhere better, and a greater deposit is obtained per unit area of leaf surface than with the conventional spray mixtures. Only from 1 to 10 gallons of the concentrated mixture is required per acre as compared with 400 to 700 gallons of the ordinary mixture. This is such a great saving in weight that it can be used in spraying from the air and the costs still kept lower than with ground spraying. In cooperation with other agencies, concentrated mixtures of certain insecticides were applied from an autogiro in experiments to control heavy mixed infestations of the spring cankerworm and fall cankerworm at Morristown, N. J., and for the gypsy moth at Freetown, Mass. In these tests

the method of application proved to be quicker and cheaper than ordinary ground spraying, and certain of the materials tested were more effective than when the same chemicals were applied by the old methods.

GYPSY MOTH AND BROWN-TAIL MOTH CONTROL

Gypsy moth and brown-tail moth suppression and control work has been continued throughout the year. The regular funds have been supplemented by allotments from the Works Progress Administration amounting to $2,026,000 for gypsy moth work in Vermont, Massachusetts, Connecticut, New York, New Jersey, and Pennsylvania, and $477,699 for work on the brown-tail moth in the New England States. These funds have been expended under the regulations of the W. P. A. and 96 percent of the men employed were taken from relief rolls. The number of men on these projects throughout the year averaged 2,492 on the gypsy moth project and 1,034 on the brown-tail moth project.

The work on the gypsy moth project was rather continuous throughout the year, whereas on the brown-tail moth project only a few men were employed until late in the fall, after which the force was maintained at a maximum throughout the winter. Cooperation with the States concerned in carrying on the work and in furnishing supervision in some of the territory has been continued much the same as during the previous year and this has made possible the coverage of a much greater portion of the territory where work is needed than would otherwise have been the case.

Work was continued in Vermont, Massachusetts, and Connecticut by men detailed from C. C. C. camps, principally between the barrier zone and the Connecticut River. It was directed from the office of the Bureau at Greenfield, Mass. Additional work was carried on from C. C. C. camps by the State conservation department in New York. All of this work was planned so as to avoid duplication of effort by the Federal, State, and local agencies who were engaged in gypsy moth and brown-tail moth control.

In cooperation with the Division of Control Investigations of the Bureau, improvements have been made on various types of machinery and equipment used in field work. Among these was the development and adaptation of a machine for reducing brush and slash to sawdust and fine shavings in order to eliminate the fire hazard of burning such material after clean-up work had been done.

On acount of the finding of gypsy moth colonies in areas remote from a water supply, spraying machines capable of developing 1,500 pounds' working pressure with suitable hose and fittings needed for this purpose have been secured, and this has made possible the spraying of areas in some cases as much as 12,000 feet from the point where the sprayer is set up at the water supply.

Special attention has been paid in removing tree growth in forest areas to see that the species not favored by the gypsy moth or only partially favored are given preference when this work is done, and an attempt has been made to encourage sprout growth of resistant species that developed following general thinning operations. In limited areas the growth is such that permanent protection from gypsy moth is possible by following these methods, but in sections where favored growth predominates intensive treatment work is necessary. This is particularly true in the territory where the bulk of the gypsy moth work is being carried on, as the extermination of the insect or its immediate reduction to such numbers as to prevent spread to other parts of the United States is the main purpose of this project. Other improvements in methods and equipment designed to reduce the cost of operation are being developed on this project.

Weather conditions during the winter, considering the territory as a whole, were favorable for this type of work. The snowfall was below normal and the temperatures were not excessively low. This made possible the examination of an unusually large acreage and the clean-up of many infestations which it would have been impossible to reach had inclement weather and deep snow impeded the progress of the work. The mild weather in many sections reduced the normal gypsy moth mortality in the egg stage, and owing to the absence of late frosts or continuous rain during the hatching season the larvae in many areas suffered little mortality from natural causes. During the month of June, when the bulk of the spraying work is carried on for gypsy moth control, weather conditions were less favorable for the work than at any time for many

years. This seriously interrupted this type of work and resulted in a great reduction in the acreage that normally would have been sprayed with the equipment available.

GYPSY MOTH PROJECT

Owing to the finding of 12 small gypsy moth infestations in Washington County, Maine, prior to the close of the last fiscal year a limited amount of work was continued in that county during the summer and fall. Egg clusters were found and treated in four towns, and the territory in and surrounding each colony was thoroughly cleaned. Four small infestations were located on residential property in the city of Calais and these were thoroughly treated. This work concluded the plan for the gypsy moth W. P. A. project in Maine.

While this work was being carried on, inspectors from the Entomological Branch of the Department of Agriculture in Canada examined territory on the east side of the St. Croix River, Charlotte County, New Brunswick. The gypsy moth has been found in small numbers on 15 properties in that county. Eight of these were in St. Stephen, the largest infestation being 12 egg clusters; 3 in Milltown, the largest infestation being 8 egg clusters; and 4 were small infestations in adjoining territory.

In New Hampshire the special scouting work in 26 towns and grants in Coos County was finished in July 1936, and no infestation was discovered. A small amount of work was done along the Connecticut River from Lancaster south to the Massachusetts line, and after this was finished the work in New Hampshire was discontinued.

Practically all of the W. P. A. work in Massachusetts and Connecticut was carried on west of the Connecticut River. In Vermont considerable infestation was found from Barnet south to the Massachusetts line but this decreased toward the barrier zone. No infestation was discovered north of Barnet or within the barrier zone area, and the isolated infestations located in Essex, Chittenden County, and Derby, Orleans County, during 1936 were examined but no trace of the insect was found.

In the Massachusetts portion of the zone, conditions are more satisfactory than for many years, but there is much infestation in certain localities between the barrier zone and the Connecticut River that seriously threatens work in the zone. This is particularly true in Deerfield, Northampton, and Russell, where sizeable areas were defoliated by the gypsy moth this summer.

The scarcity of relief labor available for this project in the Connecticut barrier-zone area has limited the amount of work that could be done there, particularly in Litchfield County and in the northern half of Fairfield County. Conditions in the Connecticut zone area are therefore not so satisfactory as in Vermont and Massachusetts. Except in the town of Granby, where heavy feeding occurred this year, infestation between the barrier zone and the Connecticut River is not so heavy as in the other two States mentioned.

In New York intensive scouting was done by W. P. A. forces in Washington, Rensselaer, Dutchess, and Putnam Counties within the zone area and in Albany, Westchester, and Putnam Counties to the west and south of the zone. No infestation was discovered as a result of this work, but in Putnam Valley, Putnam County, and in Shawangunk, Ulster County, sizeable infestations were found. The infestation in Shawangunk was located by employees of the New York Conservation Department after male moths had been taken at one of the assembling cages put out in that locality. The Putnam County infestation was discovered by men from the Civilian Conservation Corps scouting a section of that town. W. P. A. forces assisted in the intensive follow-up work, including selective thinning of favored food species and spraying at each of these infested sites, and in both localities a material reduction in infestation has been noted. Special survey work started in the territory west of the Hudson River in 1936, was completed February 28, 1937. From July 1, 1936, to February 28, 1937, 488 towns and boroughs located in 31 counties were covered but no infestation was found.

State and C. C. C. camp forces supervised by the New York Conservation Department located and treated several small isolated infestations in Columbia and Dutchess Counties within the barrier zone and in Westchester County, the Borough of the Bronx, and Nassau County to the south of the zone. Except for the infestations in Shawangunk and Putnam Valley above referred to, conditions are better in the State of New York than for several years.

This is especially true in the Bronx and on Long Island, where intensive exterminative measures have materially reduced infestation existing there.

In the section of Nassau County under State regulation on account of the gypsy moth, 1,803 shipments of nursery stock, wood products, etc., were inspected and certified as free from this insect during the year.

The small force of W. P. A. workers employed in New Jersey performed intensive scouting work in selected areas in Essex, Morris, Passaic, Somerset, and Union Counties. Much of this work was done in the township of Mendham, Morris County, where a male gypsy moth was taken at an assembling cage during the summer of 1936. No infestation has been found here during the year.

In Pennsylvania scouting work has been done in Lackawanna, Luzerne, Carbon, Monroe, Pike, Susquehanna, and Wayne Counties. Wherever infestations have been discovered intensive follow-up work has been done. The lowlands along the Lackawanna and Susquehanna Rivers were scouted during the summer and fall when water in these rivers was low. On account of the serious flood conditions in March 1936 the lowlands bordering the Lackawanna River from Scranton to its confluence with the Susquehanna River near Pittston and the Susquehanna River from the Ransom town line to the highway bridge at Nanticoke were examined, and this work was extended as far south as Sunbury. Six infestations were found. They were all within 10 miles of Pittston and well within the area of known infestation. Although the river was examined for about 100 miles on both sides, no evidence was found that the gypsy moth had been spread by the flood. Small isolated infestations outside of the State quarantined area were found in the townships of Clinton, Dyberry, and Lake in Wayne County, Clifton in Lackawanna County, and Chestnut Hill in Monroe County. The township of Clifton in Lackawanna County was included in the State quarantine effective July 1, 1937, but as the infestations discovered in the other towns were not considered difficult to eradicate or dangerous from the quarantine standpoint, the four other towns referred to were not included in the new State quarantine. No egg clusters were found at sites of infestations discovered in 1936 in the townships of South Canaan and Sterling in Wayne County, Greene in Pike County, and Lehigh in Carbon County, and it is believed that the infestations have been exterminated. A total of 80,198 shipments were inspected and certified before movement was permitted within or to points outside of the State quarantined area. In making these inspections 321 egg clusters and 665 larvae were located and destroyed. In spite of the numerous difficulties experienced since work in Pennsylvania was started, excellent progress has been made and the situation looks more hopeful each year.

GYPSY MOTH WORK BY CIVILIAN CONSERVATION CORPS CAMPS

C. C. C. camps have continued to work on gypsy moth control under the supervision of the Bureau. Their activities give protection to the gypsy moth barrier zone and reduce the danger of a westward spread of this insect.

Throughout the year 282,497 6-hour man-days were used on this gypsy moth work. This is a reduction of approximately 15 percent of the man-days available during the previous year. At the end of the year, however, there was a decrease in the men available of approximately 50 percent, which indicates a very serious reduction in the volume of work that can be done during the coming year. At the beginning of the year 1,465 juniors and 15 veterans were assigned to this work, but at the end of June 1937 only 733 juniors and 14 veterans were available for it. With this reduction the supervision was reduced from 118 foremen at the beginning of the year to only 65 at the end of the year. Some men were available at the end of the year from 20 different camps in New England, the number ranging from 5 to as high as 120 men in three camps in Massachusetts where the entire project is gypsy moth work.

During the year gypsy moth work by the C. C. C. was discontinued in New Hampshire. Decrease in personel available for this project and regulations of the Emergency Conservation Work resulted in the work in this State becoming isolated from the rest of the C. C. C. gypsy moth project, and its continuance was not warranted as a part of a program to protect the barrier zone. In Vermont the abandonment of camps has resulted in leaving unprotected several areas where serious infestation exists. The same situation

to a lesser extent exists in Massachusetts, and a severe reduction in the number of men allowed for gypsy moth work in Connecticut is resulting in leaving areas unprotected where work should be done. The 20 camps now engaged in these activities are distributed as follows: 5 in Vermont, 9 in Massachusetts, and 6 in Connecticut. All of these camps are under the jurisdiction of the Forest Service of the United States Department of Agriculture except one, which is under the United States Department of the Interior.

During the year work was done in 148 towns, and gypsy moth infestations were discovered in 105 of them, involving a total of 1,162 colonies. The records in table 7 which refer to burlap applied and larvae and pupae destroyed beneath them represent the sum total for the fiscal year. Inasmuch as caterpillars and pupae are found underneath the burlap during July it does not represent the work for the entire season.

The Forest Service has cooperated in the C. C. C. gypsy moth work during the year and furnished the services of an Emergency Conservation Work forester to assist gypsy moth foremen in combining gypsy moth cutting work with silvicultural practices.

The work has resulted in giving added protection to the barrier zone and in reducing the danger of westward spread. In many places favorable for gypsy moth increase, and in locations where danger of westward spread is great, conditions have been greatly improved, and those areas where the work has been done are in a much better condition.

Table 7 summarizes the work performed by the W. P. A. and C. C. C. personnel.

TABLE 7.—*Gypsy moth control work, fiscal year 1937*

State	Project	Scouting							Thinning		Fencing		Banding			Spraying		
		Open country scouted					Woodland scouted	Egg clusters creosoted	Woodland thinned	Trees cut in open	Wire erected	Wire removed	Burlap bands applied	Pupae crushed	Larvae crushed	Woodland sprayed	Residential properties sprayed	Trees in open sprayed
		Open areas	Road	Apple trees	Oak trees	Shade trees												
		Acres	*Miles*	*Number*	*Number*	*Number*	*Acres*	*Number*	*Acres*	*Number*	*Feet*	*Feet*	*Number*	*Number*	*Number*	*Acres*	*Number*	*Number*
Maine	W. P. A.	89,323	1,445	129,298	8,064	59,425	820	67	3	217	0	0	0	0	0	0	0	0
New Hampshire	do	34,265	324	6,608	11	47,525	0	126	0	0	0	99,979	4,441	7,740	151,622	0	0	0
	C. C. C.	5,410	65	4,760	2,372	8,044	18,338	209,287	441	317	0	0	0	72,440	335,294	0	0	0
Vermont	W. P. A.	793,380	4,057	670,222	77,392	1,963,263	429,071	46,791	239	2,583	76,698	271,150	130,267	7,175	53,529	241	0	910
	C. C. C.	150,485	930	83,828	8,462	182,609	290,362	124,266	818	1,137	0	0	458,162	51,247	1,416,074	0	0	0
Massachusetts	W. P. A.	97,743	820	116,498	17,135	143,145	183,385	1,724,734	2,905	1,441	323,424	90,263	126,344	636,206	203,010	1,814	3	0
	C. C. C.	51,495	691	190,483	66,886	102,505	199,383	5,501,015	2,386	1,590	0	0	889,789	2,831,464	12,331,780	0	0	0
Connecticut	W. P. A.	137,016	1,998	402,695	235,389	509,267	183,408	51,405	1,000	0	55,895	25,410	49,011	21,015	68,416	2,056	1	522
	C. C. C.	148,545	1,154	293,824	83,378	410,560	199,995	80,227	948	1,387	0	0	529,301	23,464	204,368	0	0	0
New York City	W. P. A.	70,778	558	136,292	152,690	1,003,581	86,526	26,757	299	298	0	0	15,491	0	101,505	23	0	0
New York State	C. C. C.	264,058	1,479	606,329	0	4,921,537	139,152	76,176	345	0	0	0	189,032	0	211,851	2,616	0	49,022
New Jersey	W. P. A.	8,279	80	26,813	2,696	99,876	8,287	0	58	0	0	0	2,445	0	0	0	0	0
Pennsylvania	do	268,646	1,969	543,533	171,467	1,583,047	424,753	367,851	3,005	88	130,668	177,691	716,530	16,369	54,657	9,081	5,762	63,798
Total	W. P. A.	1,499,430	11,251	2,031,959	664,844	5,409,129	1,316,250	2,217,731	7,509	4,627	586,685	664,493	1,044,529	688,505	632,739	13,215	5,766	65,230
	C. C. C.	619,993	4,319	1,179,224	161,098	5,625,255	847,230	5,990,971	4,938	4,431	0	0	2,066,284	2,978,615	14,499,367	2,616	0	49,022
Grand total		2,119,423	15,570	3,211,183	825,942	11,034,384	2,163,480	8,208,702	12,447	9,058	586,685	664,493	3,110,813	3,667,120	15,132,106	15,831	5,766	114,252

CONDITION OF GYPSY MOTH INFESTATION IN NEW ENGLAND

Defoliation caused by the gypsy moth in the summer of 1936 was less extensive for the infested area as a whole than it was the previous year. The total reported area showing from slight to complete defoliation was 428,622 acres, a reduction of 112,147 acres from the total of 1935. With the exception of Massachusetts all of the New England States showed less defoliation in 1936 than the year before. This was particularly true with respect to New Hampshire, where the decrease was very marked. In contrast to the other States there was in Massachusetts a decided increase in areas of defoliation in a few of the eastern counties. This was particularly true in Bristol and Norfolk. No noticeable defoliation was recorded from either Vermont or Connecticut, and in Rhode Island there was a marked decrease. In numerous portions of the infested area, particularly in Massachusetts, it was indicated that the infestation was much more widespread than usual with the possibilities that unless there was heavy winter mortality of egg clusters there would be an increase in defoliation in the summer of 1937.

BROWN-TAIL MOTH PROJECT

The brown-tail moth project was conducted under a W. P. A. allotment of funds in all of the New England States. As in the previous year, it was organized in close cooperation with the States concerned. In Maine and New Hampshire the work was under direct supervision of State officers and in Massachusetts field officers of the State had direct supervision in their respective districts. Men engaged in the work were drawn from unemployed lists through the United States Employment Service and from W. P. A. rolls and at least 95 percent were from relief rolls.

The plan under which the work was conducted called for the examination of all towns within the infested area and a number of others immediately outside for the purpose of determining possible spread and, in addition, the removal of neglected favored food plants, including apple, wild cherry, and plum from selected areas where infestations had persisted.

In the early part of the year the number of men employed was small, but increases in personnel were made rapidly, the maximum number being on the rolls in February, when 1,360 were employed.

During the fall, prior to the shedding of deciduous foliage, all crews were engaged in eliminating favored food plants, and this type of work was performed again from the end of April until the year closed. During the progress of the work 48,867 miles of roadside were examined, which involved the covering of an estimated 4,400,000 acres; 264,468 trees were cut and burned, a majority of these being worthless apple trees; 24,539,091 trees were examined; and 3,046,530 winter webs of the brown-tail moth were removed and destroyed. The State-by-State tabulation of work accomplished is shown in table 8.

TABLE 8.—*Summary of work accomplished under Works Progress Administration brown-tail moth project, fiscal year 1937*

State	Trees cut	Roadside scouted	Estimated area scouted	Trees examined	Brown-tail webs cut
	Number	*Miles*	*Acres*	*Number*	*Number*
Maine	85,017	15,104	1,359,360	6,340,168	743,601
New Hampshire	88,742	12,903	1,161,270	6,094,643	1,523,478
Vermont	22,431	5,212	470,080	6,486,479	3
Massachusetts	68,278	12,266	1,103,940	5,006,534	779,404
Rhode Island	0	993	89,370	210,225	44
Connecticut	0	2,389	215,980	401,042	0
Total	264,468	48,867	4,400,000	24,539,091	3,046,530

Observations made during the summer of 1936 showed practically no defoliation by the brown-tail moth. In a few localities in the extreme eastern part of Massachusetts there was some noticeable feeding. As a result of the work of 2 years conducted under allotment of W. P. A. funds, infestations have been decreased throughout the infested area.

The examination of towns along the western border of the infested area indicates that the insect is not spreading westward and that the clean-up of towns along this border has been effective in reducing the infested territory.

This project was closed June 30, 1937.

GYPSY MOTH AND BROWN-TAIL MOTH QUARANTINE ENFORCEMENT

CERTIFICATION OF QUARANTINED PRODUCTS

Enforcement of the gypsy moth quarantine regulations continued as heretofore, with 21 district inspectors assigned to as many districts. There was a complete shift in the territories assigned to each inspector, so that the men might obtain experience in new sections and in a variety of quarantine activity.

There were no developments requiring revision of existing quarantine regulations. In an administrative order issued March 2, 1937, a few items were added to the list of articles exempted from the regulations as noncarriers of moth infestation.

Twenty-three temporary inspectors were employed in the inspection of Christmas trees and other evergreen material used for Christmas decorations. During the 1936 season only one gypsy moth egg cluster was found on Christmas trees presented for inspection and certification. The discovery was made on a balsam fir at a nursery in southern Vermont. An 8.5-percent increase was noted in the number of Christmas trees inspected and certified for shipment from the lightly infested gypsy moth area. In Maine approximately 51,000 more trees were inspected and certified this year than in 1935. All but 5 percent were balsam firs, the demand for which has been increasing yearly. In Vermont, where approximately 75 percent of all evergreens are spruces, the demand for balsam fir exceeded the supply. Inspection of spruce boughs extended from the middle of October to early in December in Massachusetts and southern Vermont.

New England experienced the heaviest fall demand for nursery stock in several seasons. During October and part of November the assignment of additional inspectors was required in practically all the infested States. Scouting of nurseries that shipped under joint Japanese beetle and gypsy moth certificates was completed in November. No gypsy moth egg clusters were found in or in the vicinity of any such nurseries.

Throughout the year inspectors destroyed 1,257 egg clusters, 235 larvae, and 136 pupae, all taken from material destined to nonregulated points. Inspection of a 12-car shipment of lumber in November netted 125 egg clusters.

Tables 9 and 10 give summaries of the quantities of articles of the respective quarantined products certified during the year.

VIOLATIONS

Apparent violations of the gypsy moth and brown-tail moth quarantine investigated during the year numbered 696. One violation involving a host shipment of uncertified forest products from Stonington, Conn., to Greenport, N. Y., was successfully prosecuted.

TABLE 9.—*Nursery stocks certified under gypsy moth quarantine, fiscal year 1937* [1]

Material	Quantity	Certificates issued	Material	Quantity	Certificates issued
	Number	*Number*		*Number*	*Number*
Shrubs	1,110,066	5,351	Potted greenhouse plants	8,042	310
Specimen trees	24,362	1,161	White pine trees	452,997	751
Young trees	96,652	1,254			
Specimen evergreens	156,659	1,570	Total		22,600
Young evergreens	3,361,730	9,739			
Seedlings, cuttings, and small plants	1,343,477	2,464			

[1] Where the stock came from sections regulated by the quarantine on the Japanese beetle, certification covered this pest also.

TABLE 10.—*Evergreen products, forest products, stone and quarry products, and steel rails certified under gypsy moth quarantine, fiscal year 1937*

Material	Quantity	Certificates issued	Gypsy moths found	
			Egg clusters	Larvae and pupae
Evergreen products:		*Number*	*Number*	*Number*
Boughs, balsam twigs, and mixed greens ... boxes or bales	21, 646	3, 938	19	
Christmas trees ... number	634, 365	1, 361		
Laurel ... boxes or bales	8, 740	2, 346	4	
Miscellaneous ... boxes	12, 559	10, 525		
Total		18, 170	23	
Forest products:				
Barrel parts, crates, crating ... bundles, cases	80, 932	1, 093	3	
Logs, piles, posts, poles, ship knees, and ties ... carloads	5			
Logs, piles, posts, poles, ship knees, and ties ... pieces	665, 163	3, 148	60	2
Fuel wood ... cords	5, 308	388	2	
Pulpwood ... do	60, 671	2, 071		
Lumber ... board feet	45, 807, 767	5, 492	961	311
Empty cable reels ... number	20, 144	3, 328		34
Shavings ... bales	43, 291	202		
Shrub and vine cuttings ... boxes	9, 635	1, 101		
Miscellaneous ... bundles, boxes	532, 613	1, 739	76	8
Do ... pieces	91, 357			
Do ... tons	1, 265			
Total		18. 562	1, 102	355
Stone and quarry products:				
Crushed rock ... tons	665	55		2
Curbing ... running feet	171, 122	383		
Feldspar ... tons	8, 560	429		
Granite ... pieces	124, 552	5, 816	10	
Monumental stone ... do	23, 089	16, 297		
Grout ... tons	43, 966	547	1	
Marble ... pieces	678	345		
Paving blocks ... number	2, 193, 751	403		
Miscellaneous ... pieces	96, 300	514		
Total		24, 789	11	2
Steel rails [1] ... carloads	12	26	64	

[1] From abandoned railway lines.

DUTCH ELM DISEASE ERADICATION

GENERAL STATUS

Results of the year's campaign encourage the belief that the Dutch elm disease (*Ceratostomella ulmi*) can be eradicated from the United States. A nominal increase in extent of the infected zone may be attributed in great measure to increased scouting activities and more thorough coverage. The successful cooperation of Federal and State agencies, the improvement of scouting, sanitation, and removal methods, and sufficient W. P. A. funds for skilled and unskilled labor are the major factors which account for the greater smoothness, continuity, and progress made this year. Larger and better trained forces of scouts were in the field considerably earlier in the foliar season than in 1935. Particular attention was paid to clear-cutting operations in swamp districts and to railroad scouting.

SYSTEMATIC SCOUTING

Up to the beginning of the year the established cases of Dutch elm disease had totaled 15,485, including 160 cases in Connecticut, 10,109 in New Jersey, 5,156 in New York, and 60 in isolated infection centers.

Intensive systematic scouting for diseased trees began about July 1 and continued until the middle of September. A maximum of 3,110 W. P. A. scouts were employed during the season. At the peak of the season 550 C. C. C. enrollees were assigned to systematic scouting in woodland areas. By August 29, 683 crews were in the field.

A much larger and better-trained force of scouts was placed in the field this year. A large proportion of the men chosen could already identify elms and climb, so that training was concentrated on scouting technique and the recognition of symptoms of the disease. Scout schools did not close until the middle of August. An authorization received on July 23 for an increase from 10 percent to 30 percent in the personnel not drawn from relief rolls that could be hired on W. P. A. funds assisted materially in relieving the difficulties that had been encountered in filing requisitions placed with local W. P. A. offices. Authority for 143 W. P. A. supervisory appointments of experienced men to work full time also greatly assisted in completion of the season's scouting program, both in the major infected zone and at outside points. Progress in the season's scouting in most sections at the end of July was equivalent to the accomplishments late in August in 1935.

Scouting activities during 1936 more nearly approached the scheduled three surveys of the entire work area than in any previous year, notwithstanding increases in territory as a result of current findings. In addition to one complete survey of the entire infected area, the Connecticut infected zone was completely scouted on a second and a third survey. Approximately 85 percent of the infected areas in New Jersey and New York were covered a second time, while 40 percent of the New Jersey infected area and 65 percent of the New York infected zone were scouted on the third survey. Scouting of the 10-mile protective area was 100 percent complete in Connecticut and New Jersey in the first survey; approximately 30 percent complete in Connecticut and 75 percent complete in New Jersey in a second survey; and negligible in the third survey. Scouts in a cruising auto covered approximately 25 percent of the protective area in New York.

During the foliar season only 22 diseased trees, as against 39 in 1935, were discovered by scouts assigned to isolated cities in which infection had previously been discovered. Cleveland and Cincinnati, Ohio, and Brunswick, Md., showed no evidence of the disease this year. One diseased tree each was found in Baltimore, Md., and Norfolk, Va., and 19 suspected cases were confirmed in Indianapolis. The only isolated first-record infection discovered in 1936 was that found by railroad foot scouts in a wood lot approximately one-half mile beyond the eastern limits of the Baltimore & Ohio freight yards in Cumberland, Md. Discoloration in the elm was noted in the 1934, 1935, and 1936 annual rings.

Organization of railroad scouting activities was completed August 2 and the work continued until the last week in September. Men with from 1 to 3 years' experience were selected for this work. One four-man crew on foot scouted the Baltimore & Ohio right-of-way from Harpers Ferry to Clarksburg, W. Va. Ten two-man crews in cars scouted the other railroads over which imported elm logs traveled to veneer mills, paying particular attention to junction and freight make-up points. Railroads worked to the Middle West were the New York Central, Erie, Pennsylvania, Baltimore & Ohio, and Lackawanna, from New York City; the Western Maryland, from Baltimore; the Norfolk & Western from Norfolk; the Southern, Illinois Central, Louisville & Nashville, and Missouri Pacific, from New Orleans; and the Big Four and Nickel Plate in New York, Pennsylvania, Ohio, and Indiana. Kansas City was the westernmost city scouted. This is the first season that these routes have been completely surveyed by the scouting force. In addition to the finds of diseased trees at isolated points, an infestation of the smaller European elm bark beetle was discovered at Parkersburg, W. Va.

Since the smaller European elm bark beetle is the most important insect vector of the Dutch elm disease in this country, the scouts returned to Parkersburg, W. Va., to determine the extent of the infestation. The infested area, comprising approximately 7,500 square miles, is roughly bounded by Wheeling, Glenville, and Charleston, W. Va.; and Ironton, Wellston, Athens, and McConnelsville, Ohio. An intensive search was made in this area for diseased trees, with negative results. Surveys in the Ohio and West Virginia *Scolytus* area were completed December 11. Sixty specimens of beetle galleries and trunk samples collected and sent to the laboratory to be tested for *Ceratostomella ulmi* gave negative cultures.

The success of aerial scouts in locating wilted elms last year led to the purchase of three additional autogiros for the scouting of areas not easily covered in any other way. Using aerial photographic or township maps, on which the aerial observers had indicated locations of wilted elms, ground crews were able to locate, sample, and tag any such tree showing symptoms typical of the Dutch

elm disease. An area of approximately 2,142 square miles was covered by two autogiro crews in the New Jersey protective zone and in Orange County, N. Y. Out of a total of 667 individual and 36 groups of wilted elms spotted, 8 trees were confirmed as having the Dutch elm disease. The cost of scouting 500 square miles by autogiro, including the initial outlay for the plane and aerial maps, is about one-fourth that of scouting the same area on foot.

A first attempt at an elm census was made by scouting crews in conjunction with their regular duties. The total elm population of the present work area was estimated to be 11,500,000. New Jersey leads with 4,800,000, followed by New York with 4,000,000, Pennsylvania with 2,500,000, and Connecticut with 200,000.

Early-season wilting typical of the Dutch elm disease was first observed in 1937 on an elm in the town of Patterson, Putnam County, N. Y., on May 24. General wilting of elm foliage was observed early in June.

By June 1, 1937, approximately 1,300 scouts were in scout training schools. Systematic scouting began during the first week in June. By the end of the fiscal year 3,159 scouts were in the field, the large majority of whom were paid from work relief funds. Of those engaged in the work, 391 were from the C. C. C.

On May 21 four two-man scouting crews, one supervisor, and an autogiro with a pilot left for Montgomery, Ala., to begin systematic scouting of railroads in Alabama, Arkansas, Georgia, Indiana, Kentucky, Louisiana, Mississippi, Missouri, Oklahoma, Tennessee, Virginia, and West Virginia. The purpose of the flight was to complete a survey of the roads over which elm logs had been shipped. Approximately 225 miles of railroad right-of-way were covered each flight day. Aerial scouting over rough terrain in the New Jersey and New York work areas was under way by the middle of June.

Six additional cases of diseased elms in Indianapolis were confirmed before the end of the year. Total infected trees recorded to date in outlying areas are as follows: Indianapolis, Ind., 39; Baltimore 2, Brunswick 3, and Cumberland 1, in Maryland; Cleveland 33, and Cincinnati 1, in Ohio; and Norfolk, Va., 5; or 84 in all.

Samples were collected during the year from 59,661 trees showing apparent symptoms of the disease. Of these, 7,640, upon examination of the cultures, were confirmed as infected with the Dutch elm disease. Segregated by States, 109 were in Connecticut, 5,802 in New Jersey, 1,705 in New York, and 24 at isolated infection points in Indiana, Maryland, Ohio, and Virginia. Compared with the previous year there was a 16-percent increase in the number of confirmations. Last year the comparative increase was 17 percent.

On the basis of the 1936 foliar season, 7,327 cases were confirmed as compared to 5,664 during the 1935 foliar scouting season. The increase may be largely attributed to more efficient scouting over a longer period during the 1936 season. Results are definitely promising in view of the lack of spread from previous years' heavily infected area, and the slight increase in disease cases at the margin of the zone infected in 1935.

The grand total of known disease cases on record in the United States on June 30, 1937, is 23,125, of which 269 occurred in Connecticut, 15,911 in New Jersey, 6,861 in New York, and 84 at 7 isolated infection centers.

EXTENSIONS OF WORK AREA

Trees infected with the Dutch elm disease were found in or just outside the 10-mile protective zone at Branford and Guilford, Conn.; at Hopewell in Mercer County and Fairhaven, Holmdell, Little Silver, and Oceanport in Monmouth County, N. J.; and at six points in Orange County, and Huntington in Suffolk County, N. Y. The infected tree at Huntington was 6 miles from the nearest previous infection. The major diseased area, enlarged to circumscribe the newly discovered infections, included at the end of the year 276 square miles in Connecticut, 2,943 in New Jersey, and 1,914 in New York, a total of 5,133 square miles. The increase for the year was 826 square miles. The 10-mile protective zone included at the close of the year 727 square miles in Connecticut, 895 in New Jersey, 708 in New York, and 720 in Pennsylvania—3,050 square miles in all. The total work area of 8,183 square miles is approximately equal in extent to the entire State of Massachusetts.

There are a number of areas in the heavily infected zone in which known infections of the disease have been reduced to a small percentage of previous years' confirmations. Staten Island in New York, N. Y., is a good example of

greatly reduced infection. During 1934 653 diseased trees were found on the island, evidencing quite a concentration in that limited area. Infections found in 1935 numbered 327. This year only 69 cases could be found. Pronounced reductions in infections were also noted in the Bronx and in sections in the lower part of Westchester County, N. Y. Confirmations were also considerably reduced in many townships of Essex County, N. J., the county containing the heaviest infection in the State. In Caldwell Township, for example, annual confirmations from 1934 to date were 177, 398, and 41. This is particularly encouraging since this township contains a great number of elms that the disease might attack.

An amendment, effective November 9, 1936, to the regulations supplemental to Notice of Quarantine No. 71 added to the regulated area the towns of Ridgefield and Wilson in Fairfield County, Conn., where newly discovered infections were found. In New Jersey all except 5 townships and 4 boroughs in Hunterdon County, 1 township and 2 boroughs in Mercer County, all except 2 townships and 3 boroughs in Middlesex County, 2 townships and 17 boroughs in Monmouth County, all except 4 townships in Sussex County, and 3 townships and 3 boroughs in Warren County were included in the regulated area. Added areas in New York State were three towns in Orange County and one in Suffolk County.

ERADICATION AND SANITATION ACTIVITIES

Laboratory culturing of samples collected by sanitation crews from felled trees showing wood discoloration continued to emphasize the importance of ridding the infected zone of dead and devitalized trees that might be infected without showing the usual wilting symptoms and in addition are favored breeding places for the several species of bark beetles infesting the work area. In an attempt to speed up elm sanitation work by the quick removal of standing dead and dying elms already tagged for destruction, requests were placed on August 20 with the W. P. A. for 2,600 additional workers. At the beginning of the year 366,467 such trees awaited removal. In addition 758 elms in which infection had been confirmed were awaiting destruction.

Sanitation crews began work in the field under the fall program on October 8, 1936, in New York and Connecticut and on October 12 in New Jersey. W. P. A. quotas of men for the various fall activities in the respective States were approximately 380 in Connecticut, 3,600 in New Jersey, and 1,500 in New York.

Thousands of devitalized elms in swamp areas, which by their location are difficult and expensive to scout and to maintain in a healthy condition, succumbed to a newly devised chemical treatment. The method was used in sections of the 10-mile barrier strip about the periphery of the major diseased zone. To date, 624,850 trees have been thus chemically treated.

An extensive project for the removal of dead trees was undertaken in the vicinity of the first-record infection discovered at Cumberland, Md. Approximately 14,000 dead trees were cut down in a 4-mile strip stretching on either side of the center of infection. Devitalized elms were carefully pruned in adjacent sections. No Dutch elm disease was found when 60 specimens showing streaking of the wood were submitted to the laboratory for culturing, although *Verticillium* infection was present.

Pruning of trees has been carried out in a few localities. In Westchester County, N. Y., pruning extended 500 feet around isolated trees confirmed as to infection, and in Cleveland all elms within one-half mile of confirmed trees were pruned.

During the year sanitation crews removed 7,802 elms in which infection had been confirmed and 837,315 dead and dying elms. In addition, clear-cutting crews removed 789,685 trees. At the end of the year there remained standing, ready for removal and eradication, 596 diseased trees and 337,058 dead and dying elms. The grand total of elms removed to date in clear cutting, eradication, and sanitation activities is 3,324,515.

IMPROVED METHODS OF SCOUTING AND ERADICATION

Autogiros were used extensively during the year with great success, particularly along railroad rights-of-way over which imported burl elm logs had traveled to veneer mills and over rough terrain. Scouts had little difficulty in locating the wilted trees from the prepared aerial maps.

An experimental trunk-sampling project in cooperation with the Division of Forest Pathology of the Bureau of Plant Industry compared the efficiency of

trunk sampling with the routine procedure of climbing trees to obtain samples. The number of diseased trees found in the experimental wood lot was more than doubled by the use of the trunk-sampling method. This method has been employed at the Guilford and Old Lyme infection centers and in the Tamarack swamp area, Connecticut.

Clear-cutting operations, particularly in swamp areas, were facilitated by power-saw units. Four such units were used in the removal of trees in Morris, Bergen, Essex, and Union Counties, N. J. Large trees ordinarily requiring 2½ to 3 days for removal by hand crews have been cut by power saw in from 6 to 8 hours.

CIVILIAN CONSERVATION CORPS COOPERATION

Contributions to Dutch elm disease eradication work by the C. C. C. were materially reduced by the abandonment during the year of three of the six camps originally devoted to this work. One of the two camps in New York State was disbanded by April 10. The camp in Connecticut was ordered closed on May 24, and the camp at West Milford, Passaic County, N. J., was closed on June 30, leaving two camps in New Jersey and one in New York. C. C. C. enrollees participated in all phases of the work, under the supervision of experienced men trained and recommended by the Bureau.

SOURCES OF FUNDS

Funds allotted for Dutch elm disease eradication work included a regular departmental appropriation of $261,156 and W. P. A. allotments amounting to $4,258,875. The State appropriations for cooperative work amounted to $100,000 in New York, $39,100 in New Jersey, and less than half of a $25,000 biennial appropriation in Connecticut. New York funds were available for the employment of a small part of the scout force, for eradication by State crews or private contractors of all trees in the State confirmed as to infection, and for public-relations work necessary to secure authority for removal of the trees. Federal assistance was necessary to augment the limited contact work that could be performed under available New Jersey and Connecticut funds.

The work was again greatly assisted this year by the mutually helpful cooperation accorded the Bureau by officials of the three States.

INFORMATIONAL ACTIVITIES

On July 29 representatives of the Paramount News Corporation made sound shots of power saws, scouts at work, an autogiro in operation, the Morristown, N. J., laboratories, and maps showing the distribution of the disease in the United States. A comprehensive exhibit was set up for the annual convention of the American Association of Economic Entomologists in Atlantic City in December. Several radio talks and newspaper and magazine articles were prepared for release during the year.

WHITE PINE BLISTER RUST CONTROL

PROTECTIVE WORK CARRIED OUT ON 4,400,000 ACRES IN 1936

The use of relief labor made it possible to continue vigorously during the year the program of white-pine blister rust control. Through the employment of some 14,000 men directly supervised by this Bureau during the summer of 1936 and approximately 6,000 assigned to the work from the C. C. C. camps and other sources, more extensive forest areas were protected from this fatal tree disease than in any previous year.

Stands of the several economic species of white pine are permanently protected from blister rust infection when the currant and gooseberry plants (commonly called *Ribes*) are removed from among the trees, and for a protective zone of 900 feet on all sides of the stands, and when by occasional subsequent checking the area is maintained free from such plants throughout the life of the pines. During the field season of 1936, 4,404,066 acres were so protected, of which 3,340,179 acres consisted of initial work, and 1,063,887 consisted of areas covered one or more times previously since 1918. This work involved the destruction of 203,217,239 *Ribes* and required 1,075,621 man-days of labor.

The details of these *Ribes* eradication operations are given in table 11.

TABLE 11.—*Ribes eradication operations for the calendar year 1936*

Region	Area covered			Effective labor [1]	*Ribes* destroyed
	Initial work	Rework of areas covered 1 or more times previously	Total initial and rework		
	Acres	*Acres*	*Acres*	*Man-days*	*Number*
Northeastern States	1,048,305	736,073	1,784,378	527,574	55,742,673
Southern Appalachian States	1,169,073	244,196	1,413,269	44,717	5,804,474
Lake States	628,214	56,416	684,630	190,929	7,741,501
Western white pine (Idaho, Montana, Washington, including Mount Rainier)	297,781	16,043	313,824	214,868	55,415,237
Sugar pine (California and Oregon)	179,163	11,159	190,322	90,686	27,675,865
Rocky Mountain States (Colorado and Wyoming)	17,643	----------	17,643	6,847	837,489
Total	3,340,179	1,063,887	4,404,066	1,075,621	203,217,239

[1] Reported as effective 8-hour man-days; the time actually worked ranged from 6 to 8 hours per day.

OVER 10,000,000 ACRES OF PINE NOW UNDER PROTECTION FROM BLISTER RUST

The control work is aimed at protecting forest areas containing a sufficient stocking of white pine to produce a good crop of timber at maturity and making these areas safe for the continued production of white pine. Accordingly, in selecting forest tracts to be included in the control areas, preference is given to the better sites and more valuable stands of young growth.

It will be noted from table 12 that initial protection through *Ribes* eradication has now been given to 18,572,799 acres of control areas. This has resulted in the protection of some 10,000,000 acres of pine forest. Of the control area, 3,200,721 acres have been reworked. This protection has been accomplished during the past 19 years through the destruction of 756,662,550 *Ribes*.

TABLE 12.—*Status of white pine blister rust control on Dec. 31, 1936*

Region	Total pine area of sufficient value to justify protection [1]	Control area, including border zones [1]	Work accomplished 1918–36			
			Initially protected control area	Rework areas subsequent to initial protection	Effective labor [2]	*Ribes* destroyed
	Acres	*Acres*	*Acres*	*Acres*	*Man-days*	*Number*
Northeastern States	7,667,127	12,572,879	11,221,205	2,678,986	1,905,813	217,255,718
Southern Appalachian States	1,275,081	3,831,204	3,347,745	290,739	105,807	12,624,012
Lake States	1,254,394	4,260,757	1,796,831	107,673	585,545	152,381,410
Western white-pine area	2,710,129	2,710,129	1,625,712	79,097	1,249,539	301,886,409
Sugar-pine area	2,200,316	2,200,316	555,280	44,226	243,749	71,443,579
Rocky Mountain States	394,548	394,548	26,026	----------	9,056	1,071,422
Total	15,501,595	25,969,833	18,572,799	3,200,721	4,099,509	756,662,550

[1] Figures on pine and control areas are repeated from the 1936 report and are lower than will be shown after pre-eradication surveys now in progress are completed.
[2] Reported as effective 8-hour man-days; the time actually worked ranged from 6 to 8 hours per day.

In table 12 the acreage of pine area and of control area is repeated from the figures given in the last annual report. Such pine mapping as has been carried on during the past year indicates that these total acreage figures are somewhat too low. The remaining control area which should be covered is, accordingly, considerably greater than the difference between the acreages of the control areas and the initially protected areas, as shown in the table, would indicate. It is anticipated that during the fiscal year 1938 the pine and control-area mapping project will have made sufficient progress so that the first two columns of this table can be brought up to date in the next annual report.

EXTENSIVE AREAS OF PINE STANDS MAPPED

For several years considerable numbers of relief laborers under careful supervision have been assigned during the winter months to the preparation of maps showing the location and boundaries of white pine stands. The work is done during a season of the year when *Ribes* eradication cannot be carried out efficiently. During 1936, 4,169,628 acres were so mapped, this acreage including not only the pine stands contained therein but also the area of the surrounding control zone. Such mapping has been carried out during the last several years on 15,938,569 acres of control area, most of the work having been done since 1932. These maps are proving a great aid to *Ribes* eradication during the summer.

CULTIVATED EUROPEAN BLACK CURRANT DESTROYED IN LARGE NUMBERS

Several of the so-called black currants are so highly susceptible to blister rust and distribute blister rust spores in such tremendous numbers that they constitute an exception to the general rule that a 900-foot border zone around pine stands is sufficient to provide protection. The Department accordingly recommends that they be destroyed throughout white pine regions. Two such susceptible species exist in the Pacific Northwest (*Ribes petiolare* and *R. bracteosum*). The first of these grows in large numbers along some of the creeks in the western white pine region of Idaho and is destroyed by the use of chemical sprays. The other is not a problem in the principal western white pine areas but is of importance locally in parts of the Cascade Mountains and Sierra Nevada.

Of the cultivated species, the European black currant (*Ribes nigrum*) is by far the most susceptible, and most of the pine-growing States have accordingly outlawed this species completely. It was originally planted in considerable numbers in the Northeastern States, but was the subject of a general eradication campaign throughout that area 5 to 10 years ago, so its elimination has now been largely accomplished. A like campaign was carried out about the same time in the Northwestern and Pacific Coast States where western white pine and sugar pine are of commercial importance. Since emergency relief labor became available, the Lake States have been engaged in a similar program. During 1936, 87,226 *Ribes nigrum* were eradicated, nearly all of which occurred in the Lake States region.

APPROVAL OF MANY NURSERIES FOR PINE PRODUCTION

Reforestation has expanded on a tremendous scale since the organization of the C. C. C., Soil Conservation Service, and other recently established agencies. The nurseries producing the trees for the reforestation program have included large numbers of white pines in their stock, and accordingly it has become necessary to carry out extensive *Ribes*-eradication programs around these nurseries in order that the young pine trees produced therein may be healthy at the time they are sent out. The nurseries that succeed in maintaining freedom from *Ribes* in their environs are issued Federal permits which enable them to ship their white pine stock interstate.

Such nursery sanitation work was carried out in 1936 in and around 93 nurseries, of which 32 were located in the Northeastern States, 18 in the southern Appalachian region, 41 in the Lake States, and 2 in the western white pine area. These nurseries were growing 134,175,374 white pines. In protecting them, 1,058,518 *Ribes* were destroyed in 1936 on 49,781 acres.

BLISTER RUST CANKERS MAY BE CUT OUT ADVANTAGEOUSLY ON VALUABLE PINES

In some cases a single blister rust canker is sufficient to girdle and kill a pine tree, while in other instances many hundreds of cankers kill all the individual branches and thereby destroy the tree. The cankers increase in size so long as the trunk or branch on which they are growing continues to live, and branch cankers, accordingly, frequently reach the trunk and kill the tree, though in the case of large trees this may take from 5 to 20 years or longer.

During this period of growth the removal of the canker will often save individual trees of high esthetic value, a method which has been employed effectively in such places as parks and along roadsides. To a limited extent, canker removal has been tried in the State forests of New York in connection with pruning, thinning, and other work for improvement of stand.

In 1936, 167,425 cankers were removed in this manner from 73,713 white pines in the northeastern, southern Appalachian, and Lake States regions. Of the 586,371 trees examined in connection with canker elimination, 51,669 were found to be so far gone that they could not be saved, and the trees were removed. Employment on the canker-elimination project totaled 6,329 man-days during the year.

LABOR FOR BLISTER RUST CONTROL COMES LARGELY FROM RELIEF SOURCES

The accomplishments outlined in this report include not only the work directly carried out and administered under allotments to the Bureau of Entomology and Plant Quarantine, but also the accomplishments of all cooperating agencies in white-pine blister rust control. This Bureau, through memoranda of agreements and otherwise, has recognized leadership over the entire program and is responsible for pine and disease surveys, checking the maintenance of efficient standards of *Ribes* eradication, and similar matters with respect to such cooperating agencies, the degree of direct administrative responsibility varying in different cases. A considerable proportion of the labor cost is borne by the agency administering the forest concerned, or by the State, county, or private owner of the land.

Of the acreages recorded above, 3,622,402 were covered during 1936 by eradication crews paid under allotments from Emergency Relief Appropriation Acts of 1935 and 1936 direct to the Bureau of Entomology and Plant Quarantine. The C. C. C., in addition, covered 689,347 acres, devoting 285,954 effective 8-hour man-days to this purpose. The remaining acreage of 92,317 was financed by numerous other cooperating agencies. One of the largest non-Federal cooperators was the State of Idaho, which carried most of the expense of *Ribes* eradication on 11,133 acres of State-owned western white pine.

In the case of the C. C. C., that part of the work which was carried on in the national forests was handled by camps assigned to the Forest Service of this Department. The work in the national parks was undertaken by camps allotted to the National Park Service of the Department of the Interior. The work on private and State land was, in most cases, carried out by camps working under the direction of the State forester, the Soil Conservation Service, or the Resettlement Administration.

The use of relief labor for white-pine blister rust control has proved to be a highly desirable arrangement from many standpoints. It is vigorous, active outdoor work, carefully and continuously supervised, and has thus been highly beneficial to the morale, health, and physical well-being of the men concerned. Most of the laborers on *Ribes* eradication have been obtained in the immediate localities in which the work was being done, and have thus become familiar with blister rust and the methods of protecting pine stands against it. While laborers drawn from relief rolls do not cover the ground quite as rapidly or efficiently as those who might be picked individually on account of their energy and physical ability, it is probable that under no other conditions could the protection of such large areas of pine forests have been accomplished. The saving of this national-forest resource from a fate similar to that which destroyed the chestnut trees may thus be considered one of the important accomplishments resulting from the relief program.

PINE INFECTION SPREAD LITTLE IN 1936

While *Ribes* eradication protects the individual stands from which the currant and gooseberry plants are removed, the blister rust, of course, continues to spread in unprotected areas, including those forested regions in which white pines are scattered and of little or no commercial value. The new areas reached by the disease can be determined by examining the leaves of currant and gooseberry plants.

In the Northeast, blister rust infection is general throughout the white pine range in New England and New York, the amount of disease varying considerably in different localities. In Warren and Essex Counties, N. Y., and in the upper Connecticut River Valley section from 10 to 95 percent of the trees bear blister rust cankers in unprotected areas. Infection extends southward from New York State across Pennsylvania and New Jersey to Maryland, Virginia, and West Virginia.

In Maryland the disease seems to have been present in Allegheny and Garrett Counties since 1924, and has now been found in each county west of the District of Columbia. In Virginia the rust has been found in 10 counties in the pine belt, north of the center of the State, except Albermarle, Greene, Shenan-

doah, and Warren Counties, where it is probably present but has not been reported. No additional Virginia counties were reported infected in 1936, although several infected localities were reported for the first time in Highland and Rockingham Counties and in the George Washington National Forest. In West Virginia the rust was very scarce in 1936, the only infection found being on two cultivated bushes in one locality in Pendleton County. Four West Virginia counties have been reported infected in past years, namely, Pendleton, Pocahontas, Randolph, and Tucker.

In the Lake States, counties in which pine infection was found for the first time in 1936 include Keweenaw, Muskegon, Saginaw, St. Clair, and Schoolcraft in Michigan; Buffalo, Door, Eau Claire, Langlade, Outagamie, Price, Sheboygan, Vilas, Waushara, and Winnebago in Wisconsin; and Hubbard and Todd in Minnesota. During the same year it was found on *Ribes* for the first time in Buffalo, Fond du Lac, Manitowoc, Sauk, Sheboygan, and Winnebago Counties, Wis., and in Koochiching County, Minn. During the period from January 1 to June 30, 1937, further counties reported for the first time with infections on pine included Manitowoc, Brown, La Crosse, Monroe, and Sauk in Wisconsin.

The principal development in the West was the tentative delimiting of the infection in California, which, as reported last year, was first discovered on June 26, 1936. The surveys including and immediately following this discovery showed the presence of blister rust in Del Norte County on one sugar pine near Monumental and on one *Ribes* on Rowdy Creek; also in Siskiyou County on several sugar pines and *Ribes* on Indian Creek, and on two *Ribes* on Goff Creek and the Applegate River, respectively. Surveys in Oregon carried out at the same time showed sugar pines infected in Coos, Curry, Jefferson, and Lane Counties; western white pine infected in Curry and Lane Counties; whitebark pines infected in Hood River and Clackamas Counties, and *Ribes* infected at several points in Curry County and on Clear Creek in Josephine County. Blister rust occurs generally on *Ribes* in the northwestern quarter of Oregon which was not included in this survey.

In the "Inland Empire" of Idaho, eastern Washington, and western Montana, a pine-disease survey initiated in 1935 was continued in 1936 on a large scale, using especially chosen security-wage workers for the purpose. Strips 1 rod wide were run on each section line crossing all the important roads through the forest areas concerned. The results showed, as a general average, that 4.4 percent of the trees examined were infected in the St. Joe National Forest, 3.8 percent in the Clearwater National Forest, 1 percent in the Kaniksu National Forest, 0.5 percent in the Kootenai National Forest, and 0.2 percent in the Mount Spokane area. Special scouting strips were also run through portions of these forests which were known to be infected. In the territory scouted on these strips it was found that 6.8 percent of the pines examined were infected on the St. Joe National Forest, 4.3 percent on the Coeur d'Alene National Forest, 6.4 percent in the Kaniksu National Forest, 8.5 percent in the Cabinet National Forest, and 2.8 percent in the Mount Spokane forest area. The number of white pines examined on the regular strips was 289,765, while on the scouted strips 115,599 pines were checked. The infection reports relate only to trees below 20 feet in height. The heaviest infection recorded (81 percent) was in that part of one of the areas in the St. Joe National Forest located within 300 feet of a stream bed on which *Ribes petiolare* was present.

IMPROVED METHODS DEVELOPED

In further studies to increase the efficiency and to reduce the cost of *Ribes* eradication, it was found that the common species of prickly gooseberry (*R. roezli*) in California could be destroyed most effectively by cutting off the top of the plant and applying oil to the crown. One oiler with a knapsack spray tank accompanies a crew whose members pull the small *Ribes* and cut off the tops of the larger bushes. Diesel oil is then applied by the oiler, using a sprinkling hose attachment to the tank. From 5 to 6 gallons of oil are used per 100 treated plants.

Preliminary tests also indicate that dense masses of *Ribes* seedlings, which often occur in recently burned or disturbed areas, can be killed at reduced cost by spraying with oil.

Promising results of chemical-treatment tests are also being obtained in Colorado and Wyoming in a search for methods of *Ribes* eradication applicable to forest areas where the limber pine (*Pinus flexilis*), the whitebark pine (*P. albicaulis*), and the bristlecone pine (*P. aristata*) are of importance for watershed protection and other purposes.

ENFORCEMENT OF THE WHITE PINE BLISTER RUST QUARANTINE

The regulations of the white pine blister rust quarantine require a Federal pine-shipping permit in the interstate movement of five-leaved pines from the infected States to any State other than New York or the New England States. Such permits are issued only for five-leaved pines which have been grown under specified sanitation conditions. Applications for shipping such pines in the fiscal year 1938 have been received from 57 nurseries. The work of eradicating currant and gooseberry plants, the alternate hosts of the disease, from the sanitation zones surrounding these nurseries and of inspecting the zones to insure compliance with the quarantine regulations was completed in the spring of 1937 prior to the time when the rust normally appears on such plants. The environs of nurseries of 50 applicants were found to be in a satisfactory condition, including 14 Federal and 9 State nurseries growing five-leaved pines for soil conservation or reforestation purposes.

The States of Wisconsin, Ohio, Pennsylvania, and Maryland recently established white pine blister rust control areas for the purpose of protecting valuable stands of five-leaved pines. In such areas the planting and possession of currant and gooseberry plants is prohibited under State authority. The Federal quarantine was accordingly revised, effective March 1, 1937, to provide that no currant or gooseberry plants may be shipped to these States without a control-area permit, obtained from the responsible officer of such State. Fourteen States now have legally established blister rust control areas.

During the year 110 violations of the quarantine regulations were intercepted by transit inspectors, and 94 were intercepted by roadside inspectors of other projects.

CEREAL AND FORAGE INSECT INVESTIGATIONS

INSECTS ATTACKING CORN

Surveys of European corn borer populations in 1936 show that in western Ohio and in the southeastern counties of Michigan, where moisture conditions approached the normal, there were significant increases in the rate of infestation over those observed in 1935. In the drier areas, such as eastern Indiana, southwestern Ohio, parts of Michigan, and the Eastern Shore of Maryland, definite decreases in infestation were indicated. Significant increases in the rates of infestation were recorded in parts of Vermont, Massachusetts, Connecticut, Rhode Island, and New Jersey. In spite of the decrease in infestation in some areas as a result of drought conditions, the loss resulting from borer attack was higher in 1936 than in any previous year, owing in part to the increased value of the corn crop. A second generation of borers appeared in significant numbers in the Great Lakes area previously considered as a one-generation area. Experiments with these borers during the year indicate that the two-generation individuals may be physiologically different from the one-generation strain but not physiologically identical with the multiple-generation strain. Whether the two-generation habit occurring in these areas in 1936 will persist is unknown. Adult corn borer parasites to the number of 35,488 were released in 35 colonies in 10 States. This material was obtained from European and oriental importations, from domestic collections in Massachusetts, and from material originating from Canada which was reared in the laboratory, and included the following species: *Inareolata punctoria* Roman, *Microgaster tibialis* Nees, *Cremastus flavoorbitalis* Cam., *Lydella grisescens* R. D., and *Chelonus annulipes* Wesm. *I. punctoria* and *L. grisescens* appear to be particularly effective, and *C. annulipes* shows much promise in the Lakes area. A method has been developed for rearing this last-mentioned species on the Mediterranean flour moth to supply adults for colonization. Investigations of inbred lines of field and sweet corn show several of both types carrying marked resistance. The most important development in this work in 1936 is the demonstration that a considerable degree of resistance is inherent in one of the most favorable crosses, and this is not explained by the tightly wrapped tassel of this strain—a character to which most of the resistance in this line had previously been ascribed. Not only is there a large reduction in the number of borers surviving in this strain when infested previous to tasseling, but those borers that survive are stunted and lack vitality to meet winter conditions. In an extensive test of inbred lines of sweet corn certain lines exhibited resistance that is not associated with date of planting or the eclosion of the tassel, thus giving encouragement for further work of this character. Detailed studies, however, have indicated that date of

planting is an important factor in determining amount of infestation and that degree of resistance varies with the age of the plants.

Infestation by the corn earworm was relatively low in the summer of 1936, owing both to the severe drought and to the very severe weather conditions that prevailed in the previous winter. The results of hibernation studies during the winter indicate that this insect hibernated successfully considerably farther north in the winter of 1936–37 than in the previous winter, and as a consequence it appeared much earlier and in greater abundance in 1937. In studies conducted cooperatively by the Bureau of Plant Industry and the Illinois Agricultural Experiment Station, a large series of double crosses, single crosses, inbred lines, open-pollinated varieties, and top crosses were studied to determine their relative susceptibility to corn earworm attack. Although the data secured are only preliminary, 34 double-cross hybrids, 11 single crosses, 8 inbred lines, and 6 varieties showed possibilities of having resistance and are being given additional more severe tests. A method of artificial infestation has been developed and is being utilized to secure a uniform infestation irrespective of fluctuations in the normal field population. Investigations on insecticides for the control of the corn earworm, conducted at New Haven, Conn., in cooperation with the Connecticut Agricultural Experiment Station, and in Florida, have not revealed any outstanding insecticide for field application. The use of a fumigant (hexachloroethane) in paper caps for covering high-value sweet corn for protection against the earworm has been highly effective and may be feasible under special conditions. The method, however, requires further development.

INSECTS ATTACKING SMALL GRAINS

The hessian fly was at a low ebb as a result of unfavorable climatic conditions. It has been possible, however, to maintain fairly high infestations in nursery plots, and the general low populations have not seriously interfered with the work on hessian fly resistance in wheats that is being conducted in cooperation with the Bureau of Plant Industry and the agricultural experiment stations of California, Kansas, and Indiana. A number of additional varieties of wheat have been discovered to have some resistance to the hessian fly. Although these are confined primarily to spring wheat varieties, evidence has been obtained that the resistance inherent in spring varieties may be transferred to fall-sown wheats by hybridization. In California a distinction has been recognized between those wheats having two factors for resistance and others having less stable or lower degree resistance represented by derived one-factor lines. Previous results have indicated a marked difference in the reaction of given varieties of wheat to California flies as compared with the same varieties of wheat when exposed to Indiana flies under Indiana conditions. Investigations during the year have indicated that this difference in the reaction is in some degree due to biological strains of the flies rather than to differences in vegetational growth due to differences in environmental conditions. There is a marked difference between the ability of California and Indiana flies to infest the same varieties of wheat under similar climatic and soil conditions. Evidence has been accumulated, however, which indicates that resistance or susceptibility to fly attack may be materially influenced in some cases by modifications of plant structures as a result of environmental differences. Resistant types of wheat in the jointing stage have been shown under some conditions to be more susceptible to the hessian fly than when in the fall, or rosette, form. Infestation tests of wild grasses show that hessian fly larvae may develop on numerous species of wild grasses. Strains of these grasses vary greatly in resistance. Susceptibility to infestation appears to be correlated with the character of the tissues of the leaf sheaths. Usually, although not invariably, the grasses found to be most susceptible have stems that are soft and yielding. Preliminary results indicate a previously unrecognized direct correlation between the mortality in winter wheat and the extent of hessian fly infestation. Detailed studies of the relation of the developing larvae to the tissues of the fly-resistant and susceptible wheat plants show that the first-instar larvae on certain resistant plants are apparently generally prevented from molting by the pressure of the harsh tissue of these plants. The few larvae which molt and develop on these resistant plants are usually distorted by pressure of the leaf sheaths, while larvae on susceptible plants survive the first molt successfully and show no distortion at any stage of their development.

Records at Manhattan, Kans., indicate that some of the Marquillo hybrids most resistant to the hessian fly are also resistant to the wheat jointworm. A comparison of hessian fly and jointworm infestation records for 146 of these

strains, however, shows no correlation between resistance to the jointworm and resistance to infestation by spring-brood hessian flies.

Severe chinch bug infestations failed to develop during the year, although in some isloated areas barriers were required to prevent migration from small grains to corn. Work to determine the effect on chinch bug populations of eliminating certain varieties of small grains was extended to endemic chinch bug areas in south-central Illinois. The results obtained from these experiments confirm those obtained in other areas and indicate that no benefit in reducing infestation can be derived from eliminating the more favorable small grains during years of high chinch bug populations.

An extensive armyworm outbreak occurred during the year in a number of States, being most severe early in the spring in Mississippi, Arkansas, and Oklahoma, but extending late in the spring to Illinois, Missouri, Kansas, and the more northern States. Observations made on the control of this species indicated that poisoned bran baits, without the addition of sawdust, gave the best control. Experiments indicated that cottonseed hulls and alfalfa were fairly good substitutes for bran but required the addition of molasses, which greatly increased their efficiency. Pure wheat-bran baits were highly effective without molasses. Observations made on airplane dusting indicated that successful control could be obtained with calcium arsenate used at the rate of 15 to 30 pounds per acre, but that the cost was much greater than with the use of baits, and the method can be recommended only where materials for baits cannot be readily obtained and where airplane dusting equipment is already available for use on other crops.

Although the habits of the adult corn flea beetle, an important vector of Stewart's disease of corn, are now quite well determined, the biology of its larva in nature is as yet unknown. Work during the year shows that the larva can develop completely on growing bluegrass, oats, rye, and wheat, in addition to corn. In cooperation with the Bureau of Plant Industry, 789 specimens, comprising 15 species of insects from corn, were cultured during the year for the presence of Stewart's disease. No new vector was discovered.

INSECTS ATTACKING FORAGE CROPS

Progeny of alfalfa plants selected for pea aphid resistance have been increased, so a field test of resistant selections of alfalfa was possible in Antelope Valley, Calif. Populations on resistant plants in field-plot tests were less than 2 percent of those occurring on the susceptible field-plot checks and on plants from commercial fields. Highly resistant plants were obtained from three of seven varieties of alfalfa tested for resistance in California.

Surveys discovered previously unknown infestations of the alfalfa weevil in South Dakota, western Nebraska, Colorado, Oregon, Utah, and Wyoming. An investigation has been made to determine what hazards exist in the transportation of alfalfa weevils in baled hay. A method and apparatus were developed which made possible the rapid examination of large quantities of baled hay. The time required for examination of a bale was reduced to about 3 percent of that previously required. Examination of bales of alfalfa hay by this method showed that by midwinter the infestation of stacked, baled hay does not differ essentially from that of cocked, baled hay, although the initial infestation was higher in the former. Results of this investigation show quite definitely that small numbers of weevils survive in, or on, baled hay throughout the winter—one living weevil being found in a bale as late as March 17. Intensive ecological studies conducted in the Grand Valley of western Colorado during the year showed that, in contrast with other districts of the older weevil-infested territory, damage to the first crop developed before the plants were sufficiently mature to cut—thus rendering ineffective the control of the weevil by cutting which has been developed for other areas. It was discovered during the year that in the Grand Valley virtually all female weevils matured in the same year that they became adult and that they laid many eggs before the winter began. This appears to be responsible for the advantage of the weevil over the crop in the spring by permitting nearly all females to resume oviposition with the coming of the first spring warmth instead of their coming gradually into full egg production, as in Utah.

Experiments with sulphur and copper compounds for the control of the potato leafhopper on peanuts, conducted in cooperation with the Virginia Agricultural Experiment Station, have indicated that these materials are not only effective in reducing the leafhopper populations but that they result in a stimulation to the plant which materially increases yields even when no leafhoppers

are present. In 1936 the average increase in yield of field-cured peanuts from treated plots as compared with untreated ranged from 30 to 60 percent. These results confirm those obtained in previous seasons. Although this leafhopper is responsible for considerable loss in the yield of peanuts in Virginia and North Carolina, this increase in yield cannot be attributed solely to reduction in the leafhopper population.

INSECTS ATTACKING SUGARCANE AND RICE

Experiments conducted during the year gave preliminary information indicating that there is a much higher survival of the sugarcane borer in fields in which the cane trash is not burned than in fields in which such trash is destroyed by burning. This higher survival is apparently not compensated for by any increase in parasitization.

It has been found that the green bug is a vector of mosaic disease of sugarcane in Louisiana.

The use of light traps has been found to be a method giving partial control of the sugarcane beetle. Certain varieties of cane were found to be more tolerant to attacks of this beetle than others. Repellents have given excellent results in protecting planted rice from attacks by this beetle.

The West Indian cane fulgorid (*Saccharosydne saccharivora* Westwood) was discovered for the first time in the United States causing heavy injury to some varieties of cane in Florida.

It has been found that infestations of some of the worst insect pests of stored rice begin while the grain is still standing in the field. Rice grown near old stacks of rice straw was found to be 53 percent infested while in the field. In preliminary work borax has been found of value in the control of stored-rice insects. When relatively small quantities are mixed with stored rough rice the development of the insects is prevented, and borax apparently has value in preventing the molding of rice having high moisture content when harvested. Investigations are in progress to determine whether the commercial use of borax in this way is feasible and safe, the size of the dose necessary, and the limits of applicability of the method.

INSECTS ATTACKING STORED GRAIN PRODUCTS

In a study of the distribution of fumigants in vacuum tanks, utilized for the control of insects attacking stored cereal products, it was found that when a tank is filled with merchandise capable of absorbing a fumigant, an equal distribution of the fumigant is not obtained, although theoretically a gaseous mixture when introduced into a nearly perfect vacuum should distribute itself uniformly throughout the tank. An excessive adsorption by the commodity near the gas inlet and adjoining free space occurs, so that by the time the fumigant has penetrated the product it is in a much more dilute form in the places reached last, and an incomplete and uneven distribution of mortality is obtained. It has been found that recirculation of the fumigant in the vacuum vault, for the first 15 minutes of exposure, is sufficient to give even distribution and to produce the maximum effect obtainable by circulating the gas, and that a 25-percent reduction in the dosage is the maximum obtainable by recirculation. It was found impractical to fumigate flour and feeds with ethylene oxide-carbon dioxide mixture under vacuum when the temperature of the material fell below 70° F. At 85° (as in midsummer) these materials can be fumigated with dosages, per 100 pounds of material, of 5 pounds of fumigant for 3 hours, 2 pounds for 6 hours, and 1½ pounds overnight. At 70° a considerable increase in dosage is required. It was found that the susceptibility of insects to fumigants in vacuum fumigation increased as the pressure decreased and that this variation is due to differences in oxygen content of the tank rather than to pressure. The introduction of steam into vacuum tanks when the pressure registered 0.15 inch raised the temperature uniformly throughout both the tank and its contents. A temperature of 122° maintained for 3 minutes under these conditions killed several species of insects buried in wheat in a tank, including the resistant eggs of the confused flour beetle.

Claims have been made that heavier-than-air fumigants, such as chloropicrin and the carbon disulphide-carbon tetrachloride mixture, applied at the surface of grain bins in storage will penetrate effectively to the bottom of the bin. During the year it was shown by experiments, in which containers of insects were buried at each 15-foot level of a 60-foot bin, that these gases did not

penetrate to the 30-foot level and that this method of fumigation is not feasible under the conditions ordinarily encountered.

The minimum lethal dose of hydrogen cyanide, ethylene oxide, chloropicrin, ethylene dichloride, and carbon disulphide for exposures of 1, 3, and 24 hours, at 72° to 76° F., has been determined for the rice weevil, the flour beetle, and the Mediterranean flour moth, and for the eggs of the last two species. In the case of ethylene oxide, the eggs of both the flour beetle and the flour moth are more susceptible to the fumigant with a 24-hour exposure than are their respective adults. With 1- and 3-hour exposures the eggs of the flour beetle are many times more susceptible to the gas than are the adults; the eggs of the flour moth are equally susceptible with the adults for a 1-hour exposure but only slightly more resistant for a 3-hour exposure. Hydrocyanic acid gas is more toxic to the egg of the flour beetle than to the adult at all exposures, whereas the reverse is true regarding the egg and adult of the flour moth. Chloropicrin, carbon dichloride, and ethylene dichloride are in general less toxic to the eggs of the flour beetle and flour moth than to the adults, at all exposures. These results indicate the wide variation in susceptibility to fumigants, not only of different species of insects but of the different stages in their life cycle.

Determination was made of the size and kinds of flour bolting cloth necessary to remove the eggs of the principal insects occurring in finished flour. This information has already been adopted by the trade, and small unit sifters for redressing flour and removing the insects have been developed.

GRASSHOPPERS

The annual grasshopper survey conducted in the fall of 1936 in cooperation with the States indicated that one of the most widespread grasshopper infestations ever known was in prospect and that $2,000,000 for the purchase and transportation of materials would be required to control the infestation. Developments during the spring and early summer of 1937 fully justified this estimate and indicated that the survey had erred on the side of conservatism, particularly in South Dakota and Colorado, where even more severe infestations developed than had been estimated. There was no detailed survey of Texas and New Mexico, where severe infestations also developed.

Congress made $1,000,000 available for grasshopper control late in April. States set up the organization required for cooperation, and shipping of materials for grasshopper bait was begun in May. By the end of June funds available under this appropriation were practically exhausted although bait requirements for the infested areas were far from met, and it was necessary to reduce allotments to States to about half of the estimated requirement. Two factors, however, tended to ameliorate the shortage of Federal bait incurred by the limitation in funds and the unprecedented shortage and high price of bran. The first of these was the adoption of a new formula for bait, developed by research during the previous year, which made it possible to increase the sawdust in the mixture from the 50 percent previously used to 75 percent through the use of bran containing the shorts and middlings. The second was the much greater contribution of materials by States, counties, and individual farmers than in any previous Federal campaign. Some States furnished all the materials required except the poison, and many of them supplied all of the sawdust needed in the mixture.

The development of an extensive outbreak of the long-winged migratory grasshopper in eastern Colorado and northwestern New Mexico created an emergency which prompted the governors of those States to call out the National Guard. In these sparsely settled areas farmers were unable to supply the labor for mixing stations and distribution of bait and the transportation of materials needed to prevent complete loss of crops and a subsequent migration of this truly migratory species into more productive areas of these and adjoining States.

By the end of the fiscal year bait materials had been shipped into Arizona, Arkansas, California, Colorado, Illinois, Iowa, Kansas, Michigan, Minnesota, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, Wisconsin, and Wyoming.

The full results of this campaign cannot be determined until the end of the summer, when an estimate of losses and savings will be available. Generally successful results have been reported where it has been possible to supply sufficient baits and where good crop prospects have encouraged the farmers to consistent control effort.

MORMON CRICKETS

The most general and severe infestation by the Mormon cricket in history occurred during the year. It included parts of Montana, Wyoming, Colorado, Utah, Nevada, Idaho, Oregon, Washington, and small areas in North Dakota and South Dakota. A cooperative control campaign was made possible in Montana, Wyoming, Colorado, Utah, Oregon, and Washington by an allotment of funds from the Works Progress Administration. Labor and most of the necessary supervision were provided under Federal funds. States and counties furnished most of the materials, mixing facilities, and transportation for crews and materials. Control operations were conducted in Idaho and Nevada through independent State Works Progress Administration projects. The most extensive operations were carried on in Montana and Wyoming, where the infestation was most intense and widespread and where it threatened the most extensive cultivated areas. Mixing dry sodium arsenite with lime and applying it with hand or power dusters was the method most generally used for control. This dust was applied to cricket bands migrating to the cultivated areas and was used to clear grainfields of crickets which had hatched there or which had gained access to them through migration. Many miles of galvanized-iron fencing, used effectively as barriers, directed the migrating bands into pits, where they were destroyed. Oiled irrigation canals were used to advantage as barriers to the migration where these were favorably located. Thousands of bushels of crickets were destroyed in this way. Burners and poisoned baits were used to a limited degree but with indifferent results. In areas of most intense infestation all the facilities available were necessary merely to protect crops. At the end of the fiscal year it was evident that to a large degree this object had been accomplished. Losses had been limited to from 10 to 15 percent where a fight was actively waged, whereas otherwise the heavily infested small grains would have been almost entirely destroyed. In some areas the crickets have been completely cleared out of the cultivated crops and the migrating bands have been destroyed for some distance into the hills away from farms. Although the campaign is not yet completed and, as stated, it has necessarily been maintained primarily on a crop-protection basis, there is general agreement that it has resulted in a saving in crops valued at many times the cost of the campaign.

EUROPEAN CORN BORER INSPECTION AND CERTIFICATION

Inspection and certification service to conform with the requirements of the State quarantines of Arizona, California, Colorado, Georgia, Louisiana, Nevada, Oregon, Texas, and Utah continued as previously organized. Following the stationing of Japanese-beetle inspectors in West Virginia and Ohio, the only remaining men working exclusively on European corn borer certification were the inspectors in Detroit and Indianapolis. The bulk of the inspection work was performed by men engaged in both Japanese beetle and European corn borer inspection, and, in the New England area, in gypsy moth certification as well.

This year 19,784 certificates were issued to cover quarantined plant material, principally dahlia tubers, valued at $209,050. This compares inversely with last year's inspections involving issuance of 22,133 certificates to cover material valued at $165,293.

BLACK STEM RUST QUARANTINE ENFORCEMENT

The Federal quarantine relating to black stem rust is designed to prevent the shipping of rust-susceptible species of barberry and *Mahonia* into Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming, where the eradication of rust-spreading barberry bushes is carried on. Permits for shipping to these protected States are issued for premises where, as determined by inspection, only rust-resistant species of these plants are grown. During the year such permits were issued to 23 nurserymen and 1 dealer. Transit inspectors intercepted, in the year, 13 shipments that had been consigned in apparent violation of the quarantine.

BARBERRY ERADICATION

For the past 25 years stem rust has caused annual losses in the United States averaging more than $27,000,000. During certain seasons, such as 1916 and 1935, when weather particularly favored the development and spread of the fungus, damage in a single year has exceeded 100,000,000 bushels of grain.

There are two important sources of stem rust inoculum in the northern part of the United States, (1) the remaining rust-susceptible barberry bushes, and (2) rusted grainfields in Texas and Mexico, where the summer stage of the disease survives throughout the year. The relative importance of these sources varies from year to year, depending upon weather and other crop conditions. The first rust found on grains and grasses in the spring is in the immediate vicinity of remaining barberry bushes. In fact, if weather favors the spread of rust, the fungus multiplies rapidly near these inoculum centers, and with continued warm, moist weather the local spreads coalesce early in the season, causing widespread epidemics before the crops mature. Only occasionally during the past 25 years has stem rust, spreading from the South, become epidemic in the spring wheat-growing States in time to do appreciable damage.

Recommended measures for the control of stem rust include (1) eradicating rust-susceptible barberry bushes in important grain-growing States, (2) selecting for seed the more rust-resistant varieties of grain that are otherwise adapted to the area, and (3) planting spring grains early on well-prepared soil.

NINETY-ONE MILLION RUST-SUSCEPTIBLE BARBERRY BUSHES DESTROYED DURING FISCAL YEAR

During the year 91,710,896 barberry bushes were destroyed on 9,417 properties in the 17 States participating in the barberry-eradication program. The expanded program, made possible with allotments of emergency funds, permitted a careful inspection of all native and planted shrubbery on 60,237 square miles in 315 counties. In table 13 are shown, by States, data relating to the progress made in control work during the year. To avoid misinterpreting this information it should be kept in mind that figures in Virginia, West Virginia, and Colorado are hardly comparable with those in other States of the area, as much of the work conducted in these States during the year has been in areas where native species of barberry are prevalent. In the Virginias *Berberis canadensis* is being eradicated in the important grain-growing communities, and in Colorado much of the work was done in the southwestern part of the State where *B. fendleri* is prevalent. In these States native species of barberry grow in patches, often several rods in diameter, which accounts for the relatively large numbers of bushes destroyed.

TABLE 13.—*Progress in barberry eradication during fiscal year 1937*

State	Properties cleared of bushes	Barberry bushes destroyed	Territory surveyed	Security-wage earners		Proportion of all personnel taken from relief rolls
				Maximum employed	Employment	
	Number	*Number*	*Square miles*	*Number*	*Man-hours*	*Percent*
Colorado	57	1,715,456	288	138	136,812.50	95.80
Illinois	547	5,541	7,011	319	288,683.50	92.77
Indiana	203	25,518	4,976	161	140,850.00	91.09
Iowa	541	8,288	9,469	268	228,759.25	91.89
Michigan	1,220	48,996	1,169	452	310,941.50	93.73
Minnesota	558	7,720	5,655	265	336,099.25	91.59
Montana	47	367	875	52	36,044.50	97.21
Nebraska	75	364	8,183	177	107,382.00	92.38
North Dakota	24	604	1,100	110	56,810.50	94.80
Ohio	665	131,285	7,483	303	343,561.33	94.13
South Dakota	6	25	622	32	26,932.50	90.96
Wisconsin	540	15,591	4,143	337	270,763.75	91.73
Wyoming	2	9	173	0	2,614.50	100.00
Total	4,485	1,959,764	51,147	2,614	2,286,255.08	----------
Missouri	411	2,527	6,782	229	180,718.00	95.34
Pennsylvania	2,227	1,003,494	1,473	303	328,594.25	93.65
Virginia	1,412	52,870,548	457	460	552,092.00	95.17
West Virginia	882	35,874,563	378	390	402,289.25	97.80
Total	4,932	89,751,132	9,090	1,382	1,463,693.50	----------
Grand total	9,417	91,710,896	60,237	3,996	3,749,948.58	94.50

Since the beginning of the barberry-eradication program in 1918, nearly 24,082,567 bushes (mostly *Berberis vulgaris*) have been destroyed in the 13 States that comprise the original control area, and an additional 124,102,230 bushes have been destroyed in Missouri, Pennsylvania, Virginia, and West Virginia since 1935, when similar work was undertaken in these States.

During the year control work was conducted largely with men obtained through local reemployment offices. After a brief training period they were assigned to field work under the direction of experienced supervisors. Each eradication unit was composed of 5 to 10 men and each supervisor was responsible for 3 to 5 crews.

The field procedure varied with the type of territory in which work was done. In certain counties having a high percentage of the land under cultivation the fence rows, wood lots, and all planted shrubbery were carefully inspected. In wooded areas, including bluffs along rivers and other streams, a single foreman directed as many as 10 to 12 men in a single crew. Under such conditions eradication work was usually begun in known areas of infestation to permit the men to become acquainted with the distinguishing characteristics of the bush, and the strip-scouting method of survey was continued until all territory within 2 miles of the last bush found had been carefully inspected.

As in the past, salt was the principal chemical used for eradication purposes. Chlorates were employed to some extent, particularly for treating native barberries in Colorado, Virginia, and West Virginia. Fuel oils and salt brine were tried experimentally, but a further check of results is necessary before a definite statement can be made as to the relative effectiveness of these materials. Bushes were dug or grubbed only when the application of a chemical might be injurious to nearby shrubs or trees. During the year 5,694 tons of salt and 15,984 pounds of a proprietary weed killer containing sodium chlorate and other ingredients were used.

STEM RUST CAUSED VERY LITTLE DAMAGE IN 1936

In 1936 stem rust caused relatively little damage. There were two principal reasons for this. (1) The uredial stage of the rust was not very abundant in the spring in Texas and Oklahoma, and (2) although barberries remaining in the barberry-eradication area rusted heavily, the abnormally dry weather caused premature ripening of the crops, thus preventing development of the fungus on grains.

Surveys in the fall and winter of 1935 had confirmed previous tentative conclusions that the uredial stage of rust usually becomes established and overwinters more abundantly in the earlier sown fields in Texas and northern Mexico, and occasionally in Oklahoma and Arkansas. Because of dry weather in southern Texas in the fall of 1935, wheat was sown late and did not become generally infected with rust. In northern Texas rust that overwintered in certain early sown fields developed rapidly in the spring of 1936, causing considerable damage in limited areas. While the rainfall in May was above average at certain points in northern Texas, there was not a repetition of the 1935 epidemic, primarily because there was no general distribution of inoculum early in the season. That spores were blown northward late in May is indicated by the presence of early infection in Oklahoma and Kansas. Except in low places and late fields, however, there was no appreciable loss. In northeastern Kansas there was damage in late fields, but the development of the disease in the western part of the State and in most of Nebraska was greatly retarded by the drought.

In general far fewer spores were carried northward by the wind than in 1935, as shown by examination of spore traps exposed at various points throughout the barberry-eradication area.

While there was a tremendous amount of rust on remaining barberries, the attack sometimes being so heavy as practically to defoliate the bushes, local epidemics of rust on grain were restricted largely to States east of the Mississippi River, where moisture was more abundant. Drought and high temperatures in the upper Mississippi River Valley prevented the development of widespread epidemics. Had the weather been normal it is probable that heavy rust would have occurred in many local areas.

The dangerous role of barberries in the production and perpetuation of parasitic races of stem rust (*Puccinia graminis tritici*) is apparent from the following information obtained in 1936: From 151 collections of aecial material

on barberry and uredial material in the immediate proximity of barberry bushes 204 cultures were identified, comprising 24 different races, the ratio of races to collections being about 1:6. From 645 collections of uredial material collected at a distance from barberries 832 cultures were identified. These comprised 14 races, the ratio of races to collections being about 1:46. Several races obtained from barberry are much more virulent on certain varieties of wheat than those obtained away from barberry. There is also further evidence that one of the races of rust most prevalent during recent years (race 56) originated on barberry bushes within the past 10 years.

MORE STEM RUST IN 1937

There was very little evidence of stem rust overwintering in Texas and northern Mexico during the winter of 1936–37. Late in March and in April, however, rust developed rapidly in northern Mexico, and more or less sporadically in Texas, depending upon the amount of rainfall. By May 30 there was from 35 to 50 percent of rust on the winter wheat in the Bosque River Valley and 15 percent in the area north of Dallas.

Winter wheat in northern Oklahoma matured normally, with little damage from stem rust. In eastern Kansas, eastern Nebraska, and western and northern Missouri crops were heavy and succulent, and a week to 10 days late. Weather favored rust, with the result that serious damage occurred, particularly in late fields of the more susceptible soft-wheat varieties. Severe damage to winter wheat has occurred also in western and northern Illinois and central Indiana, with some damage reported from central-western Ohio, southern Wisconsin, southern Minnesota, and southern and eastern South Dakota. Local epidemics of stem rust have developed in the vicinity of barberry bushes in Virginia, West Virginia, and Pennsylvania, with a marked decrease in the amount of damage noted in areas where the eradication of barberry bushes has been largely accomplished.

Stem rust is developing on susceptible varieties of spring wheat in western Minnesota, eastern South Dakota, and eastern North Dakota, and severe damage will most likely occur, particularly in late fields.

SEVENTEEN ADDITIONAL SPECIES OF BARBERRY FOUND SUSCEPTIBLE TO ATTACK BY STEM RUST

Further investigations were conducted to determine the susceptibility of certain species and varieties of barberry advertised in catalogs and trade journals. Those found highly resistant when tested under natural conditions were given further study under controlled (greenhouse) conditions in St. Paul, Minn. More than 150 different species and varieties of *Berberis* have been brought together in the experimental plots at the foreign plant introduction garden at Bell, Md., and others are being added as they are encountered in connection with the nursery-inspection work or advertised for sale.

Inoculations made during the year have proved that the following species and varieties are definitely susceptible to attack by stem rust: *Berberis henryana*, *B. tischleri*, *B. actinacantha*, *B. bullata*, *B. chitria*, *B. concolor*, *B. consimilis*, *B. coralliana*, *B. dasystachya*, *B. farrerii*, *B.* hybrids Carmine, Comet, and Coral, *B. macracantha*, *B. poiretii* var., *weichangenensis*, *B. rehderiana*, *B. rubrostilla*, *B. vulgaris a flore gracile*, and *B. wilsonae stapfiana*.

When certain species of barberry are found to be highly resistant to the disease, seedlings grown from seed produced on the resistant bushes are tested as a further precaution against releasing, for interstate shipment, a variety or hybrid which, although itself immune, might produce susceptible seedlings.

During the year selected plants belonging to 40 species were inoculated under greenhouse conditions, with the result that 3 additional species, *B. auricoma*, *B. guimpelii*, and *B. parvifolia*, are now definitely classed as susceptible, and 4 species, *B. dictyota*, *B. gracilis*, *B. sanguinolenta*, and *B. pinnata*, have been determined as highly resistant. Further tests will be made, however, before these last are approved for propagation within the protected area.

ACCURATE IDENTIFICATION OF BARBERRY IMPORTANT IN CONNECTION WITH QUARANTINE ENFORCEMENT

The object of Quarantine No. 38 (revised) is to prevent, through education and regulations, the interstate movement (into or between States comprising the protected area) of susceptible species of barberry. In connection with this

work accurate identification of all barberries encountered by Federal quarantine inspectors, State nursery inspectors, and eradication supervisors is extremely important. The taxonomic work is carried on at the Arnold Arboretum, Jamaica Plain, Mass., where the best facilities are available. As previously indicated, the genus *Berberis* contains a great many species, varieties, and hybrids, and, further to complicate field work, many of the species and variety names in common use are synonyms.

During 1936 more than 200 *Berberis* and *Mahonia* specimens were submitted to the Bureau for identification by field inspectors and property owners. In addition, some 200 questionable bushes were identified in the field. During the year the key used in classifying barberry specimens was enlarged to include more than 230 species, varieties, and hybrids.

Records show that during 1936 22 nurseries applied for permits to ship immune barberries into and between States protected by the Federal quarantine. Prior to granting this authority, 4,740 acres of nursery stock were inspected with the result that 137 rust-susceptible barberries were destroyed. Twenty-one nurserymen were authorized to ship immune species of barberry interstate and one nurseryman was given a dealer's permit for the same purpose. In addition to the bushes destroyed in nurseries, the Federal nursery inspector, in cooperation with State nursery inspectors and State leaders of barberry eradication, removed 950 susceptible barberries from parks, arboretums, and private grounds within the barberry-eradication area.

BARBERRY ERADICATION AIDED BY INFORMATIONAL ACTIVITIES

During 1936 the steadily increasing demands for information relating to the control of stem rust of cereals were met by (1) releasing approved magazine articles, (2) giving illustrated talks before school and adult groups, (3) placing demonstrations at seed shows and local fairs, (4) distributing brief circulars in advance of field operations, and (5) carrying on a cooperative educational program with public schools. The twofold purpose of the educational work is to stimulate property owners to keep their farms free of rust-susceptible barberry bushes once the initial eradication work has been completed, and to encourage the reporting of badly rusted grainfields or areas known to be infested with barberry bushes as a guide to communities in which survey work is urgently needed.

Table 14 summarizes results of informational work conducted during the period 1928 to 1937. Many elementary and high schools throughout the north-central part of the United States are now including the study of stem rust as a part of the regular course work in agriculture or general science.

TABLE 14.—*Summary of results of informational work, by States, July 1, 1928, to June 30, 1937*

State	Counties completed	Demonstrations given			Total attendance	Total properties reported	Total bushes reported
		Grade schools	All schools	Schools and other organizations			
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Colorado	22	852	1,013	1,018	31,853	35	307
Illinois	20	2,348	2,485	2,540	57,562	355	464
Indiana	33	1,021	1,699	1,764	134,211	159	795
Iowa	35	4,041	4,761	4,879	477,989	886	82,040
Michigan	25	2,945	3,322	3,383	893,401	799	7,197
Minnesota	35	3,911	4,232	4,747	183,816	570	3,450
Missouri	0	0	0	5	955	0	0
Montana	27	1,971	2,067	2,075	54,314	37	115
Nebraska	24	2,116	2,275	2,321	51,425	102	1,439
North Dakota	22	3,425	3,727	3,749	89,077	27	222
Ohio	8	419	530	552	23,184	123	2,813
South Dakota	18	1,701	1,885	1,965	82,392	42	115
Wisconsin	2	286	300	318	7,527	109	279
Wyoming	9	446	494	505	11,488	10	49
Total	280	25,482	28,790	29,821	2,099,194	3,254	99,285

TRUCK CROP AND GARDEN INSECT INVESTIGATIONS

WIREWORMS

Investigations on the biology and control of wireworms (*Limonius californicus* Mann. and *L. canus* Lec.) which infest the irrigated lands of the West have been continued in California, Washington, and Idaho, emphasis being placed on testing soil fumigations with naphthalene and dichloroethyl ether, soil-surface applications of sulphur in an attempt to prevent or reduce egg deposition by wireworm adults, and the effect of crop rotations on wireworm infestations.

It was found that the damage caused by wireworms to onions could be decreased greatly by the incorporation into the soil of 800 pounds of crude naphthalene per acre, while the land was being plowed, and during a time when soil temperatures were 70° F. or higher. Although best results have been obtained with naphthalene fumigation of the soil when the temperatures reach 70° or higher, experiments performed in the State of Washington indicated that worth-while results may be obtained with naphthalene even when the soil temperature to a depth of 12 inches ranges from 65° to 67°. Comparative tests with several other fumigants showed that crude naphthalene at the rate of 800 pounds to the acre was more effective and cheaper than either calcium cyanide at the rate of 400 pounds to the acre or a commercially prepared fumigant consisting principally of crude naphthalene and silica at the rate of 22 parts of the former to 78 parts of the latter. In these tests crude naphthalene killed approximately 92 percent of the wireworms, calcium cyanide killed approximately 78 percent, and the commercially prepared soil fumigant killed 68 percent.

In California dilute solutions of dichloroethyl ether at a concentration of 5 cc of this material in 1 gallon of water were found to be highly toxic to wireworms when drilled into rows of beans used to attract and concentrate the pests. Tests on plant growth demonstrated that at concentrations of 1, 3, and 6 cc respectively, per gallon of water, this material caused no apparent injury to growing lima beans. Higher concentrations caused plant injury. Evidence was also obtained that applications of dilute solutions of this material of sufficient strength to be effective against wireworms will not injure tomatoes, potatoes, cabbages, and corn. Before such treatment is advocated as a general practice, however, further experimentation is necessary.

Field-plot tests in the State of Washington indicated that the soil-surface application of sulphur at rates of 400 and 800 pounds per acre, respectively, did not have any appreciable effectiveness in preventing egg deposition by the adults of either the sugar-beet wireworm or the Pacific coast wireworm.

The late planting of potatoes in the irrigated section of the Pacific Northwest where wireworms are abundant offers a means of escaping maximum injury by these pests. In Washington during the season of 1936, an average of 57 percent of the potatoes planted on April 7 and harvested during the period from August 10 to 17 were injured by wireworms, whereas in comparable plantings made on June 23 and harvested early in November an average of approximately 44 percent of the tubers showed wireworm injury. Actually the difference in relative wireworm injury suffered by early planted and late planted potatoes was less in 1936 than during previous years because conditions during that year were such that the wireworms did not begin their seasonal migration downward until a later date than normal.

Crop-rotation studies continue to bear out the information previously gained that wireworm abundance increases rapidly in fields planted to red clover and sweetclover, that the rate of increase is retarded in fields planted to truck crops, and that practically no increase of these pests occurs when alfalfa or pasture grasses are grown.

Field studies on the Gulf wireworm in Alabama showed definitely that there was a difference in the number of wireworms found in land planted year after year in potatoes as compared with the number occurring in new ground and in old field sod. The wireworms were less abundant in fields where suitable crop rotation was practiced and in cotton fields than in fields where potatoes were planted year after year. It has been demonstrated that while the trapping of adults under crop remnants raked into windrows followed by the burning of such windrows destroyed a high percentage of adults, this method was not effective unless the soil so treated was cleaned thoroughly of plant remnants and the soil surface leveled off. Soil fumigation with crude naphthalene, following the methods and dosages used successfully against wireworms in the Pacific Northwest, was not successful in combating mixed populations of the Gulf wireworm and the sand wireworm in experimental field tests performed at

Charleston, S. C., The wireworm populations were not reduced significantly in these tests, nor was there any significant difference in the number and weight of tubers showing wireworm injury which were produced in the treated plots and of those from the untreated plots.

BEAN AND PEA INSECTS

Field experiments with insecticides in Ohio and Virginia on beans grown for the green-bean market or for canning have shown definitely that the Mexican bean beetle can be controlled best at a minimum cost with sprays or dusts of cube or derris. Results with cryolite sprays or dusts have continued to indicate that the control value of this material is questionable, although it gave a fair degree of control under some conditions. In the East the performance of cryolite apparently varies to a certain extent from year to year in accordance with variations in weather conditions and possibly in the composition of the insecticide. In Colorado the results from tests on irrigated beans grown for the dry-bean market demonstrated that, based on increased yields and calculated financial returns, cryolite spray gave the most efficient control and was significantly better than zinc arsenite spreay, a material commonly employed in that territory. Sprays and dusts containing rotenone were also effective against the bean beetle in the West, but they cost more than the cryolite spray. Since wide publicity had been given to an article which indicated that magnesium sulphate (Epsom salt) used as a spray in the proper concentration constituted an effective control of the Mexican bean beetle, experiments with this material were resumed in the spring of 1937, even though tests conducted in Ohio during 1928 had demonstrated that this material was not toxic to the Mexican bean beetle. Laboratory tests with Mexican bean beetle larvae, using dosages of Epsom salt 100 times as great as the lethal dosage of calcium arsenate, showed that the test larvae fed on the treated bean foliage, that they consumed as much leaf area as the larvae placed on untreated foliage, that they molted successfully, and that there was no resulting mortality which could be attributed to Epsom salt. Since laboratory studies during 1936 disclosed that the active ingredients of derris were translocated in treated plants in such a manner as to prevent extensive feeding of the Mexican bean beetle on foliage that developed on the plants after the insecticide had been applied, it was decided to ascertain the residual effect of derris on bean foliage in various widely separated localities in the United States where wide variations in temperature, humidity, and intensity of sunlight occurred. Bean plantings were made for this purpose at New Haven, Conn., Norfolk, Va., Columbus, Ohio, Baton Rouge, La., Madison, Wis., Manhattan, Kans., Grand Junction, Colo., Twin Falls, Idaho, Ventura, Calif., Corvallis, Oreg., Puyallup, Wash., and Phoenix, Ariz. These plantings were treated with a derris spray, and samples of leaves were taken at given intervals and sent to Columbus, Ohio, for analysis. In every case, rotenone was recovered in sufficient quantities at the expiration of 2 weeks after treatment to be indicated by the colorimetric method and goldfish test. At Madison, Wis., Grand Junction, Colo., Twin Falls, Idaho, Corvallis, Wash., and Columbus, Ohio, derris showed a slower loss of toxicity than at the other laboratories. Neither the intensity of sunlight nor high humidity alone appeared to affect significantly the decomposition rate. At Phoenix, Ariz., where daily temperatures averaged 100° F. during the period of the test, rotenone was recovered after 10 days. At Ventura, Calif., where no rain fell during the test, all of the toxicity had disappeared at the end of 4 weeks. In general, these tests demonstrated that the residual properties of derris were such that in any part of the United States where cultivated plants are commonly grown this insecticide could be used effectively against the species of insects which it is known to affect.

Dust mixtures containing rotenone gave excellent control of the pea weevil in large-scale field tests performed in Idaho, Washington, and Oregon. In Oregon 60 fields, involving approximately 300 acres of peas grown for canning, were included in the tests. The greater part of this acreage was treated with a dust mixture containing 0.75 percent of rotenone with talc as the diluent. This combination appeared to be more effective than dust mixtures containing 0.25, 0.50, and 0.75 percent of rotenone, respectively, with diatomaceous earth as the diluent. Two applications of these dust mixtures were made to all of the fields with specially constructed power dusters. Based upon an examination of the peas at the viner, the control achieved in the treated fields averaged approximately 97.7 percent. In the Washington canning-pea section many tons of rotenone dust mixtures were applied to the weevil-infested sections of pea

fields, more particularly to the strips from 25 to 30 feet in width around the edges of the fields, where the hibernating weevils had congregated. Under favorable weather conditions the majority of the infestations in the treated fields were reduced more than 95 percent and in some instances the weevil population was reduced 99 percent or more. From one to three applications were made to these field borders, depending upon the magnitude of the movement of the weevils into the fields after such fields were dusted. The cost of this method of control to determine its true economic value has not been worked out as yet. Additional work on the border trap-crop method of control indicated that large numbers of pea weevils can be concentrated in the early planted strips, where they can be killed by plowing under deeply and cleanly, but that this method cannot be depended upon to control the weevil, since the seasonal period of emergence of the weevil from hibernation may vary from year to year, thus reducing the effectiveness of the border trap crop. In tests conducted with several different types of tillage equipment it was shown that the deep plowing under of shattered peas on the soil surface with a moldboard plow equipped with proper covering attachments prevented a large number of the weevils contained in such peas from emerging to the soil surface. Imported parasites (*Triaspis thoracicus* (Curtis)) of the pea weevil, comprising approximately 21,000 living parasite adults, were released in Idaho, but no definite results were obtained on this phase up to the close of the year. Biological studies disclosed that in Idaho the pea weevil was able to survive minimum temperatures of —16° F. but was not able to survive a minimum of —30°, thus indicating a climatic limitation of its distribution as an economic pest. It was determined that the percentage of mortality of the overwintering weevils was directly proportional to the degree of protection afforded by snow or other covering during periods of low temperature.

The pea aphid continued to cause heavy loss to the pea growers in many of the major pea-producing sections of the country, particularly in Maryland, Wisconsin, western New York, and Ohio. From the data accumulated during the past two seasons the outlook for a successful control of this long-standing pest with rotenone-bearing materials is promising. Particularly good results were obtained with a derris or cube dust mixture containing a specially prepared spreading agent, such a dust being prepared by atomizing a sodium oleyl alcohol sulphate into the derris or cube dust mixture while it was being revolved in a dust mixer. Field tests with derris and cube sprays or dusts demonstrated that the aphid mortality progressed over a period of time, ranging from a week to 10 days or longer, after the treatments were applied and that the infestation in the blossom clusters and in the growing tips of the pea vines was reduced to a greater extent than it was on the entire plants. This latter development is important, since the damage to the blossom clusters and to the growing tips of the plants has a pronounced effect on the yield of the peas. Analysis of canned peas from plants that had been treated by dusting or spraying with derris at the dilutions found to be effective in the control of the pea aphid showed that no trace of derris constituents could be detected in any of the peas that had been removed from the treated plants. The time of application of the treatment also appears to be a very important factor in the economic control of the pea aphid, and this important phase of the problem remains to be developed for all affected areas.

Field experiments in eastern Virginia, in an attempt to determine the relative effectiveness of various insecticides for the control of the corn earworm on lima beans, disclosed that the best control was obtained with cryolite dusts or sprays. In the dust form the cryolite was applied either as an undiluted dust or at the rate of 60 parts of cryolite and 40 parts of talc or sulphur. In the spray form the cryolite was used at the rate of 3 pounds to 50 gallons of water. In addition to reducing the number of wormy pods as compared to those produced on untreated plots, applications of cryolite dusts and sprays increased the total number of pods produced. Phenothiazine gave good protection against corn earworm injury but failed to show a significant increase in the number of pods produced as compared to the untreated plants. Negative results were obtained with various dust mixtures of derris, cube, pyrethrum, nicotine, and sulphur. The Division of Insecticide Investigations of this Bureau made analyses of samples of shelled and unshelled lima beans from plots that had been treated with cryolite and found that the fluorine residue remaining on the unshelled beans (pods) was in many instances above the tolerance established for fluorine on fruit (0.01 grain per pound). Analysis of the shelled beans, however, showed in most instances that the quantity of fluorine on such beans was well below 0.01 grain per pound. Analyses were also made of canned beans from cryolite-

treated plants that had been run through the commercial process of vining and canning. The result of the analysis of this product indicated that when lima beans are treated as described above and run through the ordinary washing process, the canned product is free from harmful fluorine residues. Since lima beans are shelled before being consumed, it appears that cryolite may be applied safely for the control of the corn earworm on this crop.

TOMATO INSECTS

Although the tomato pinworm has continued to cause serious losses in southern California, good progress has been made on biological and control studies. Results of field-plot tests have indicated that a cuprous cyanide dust mixture with talc as the diluent (1 to 5), cuprous cyanide used as a spray at the rate of 3 pounds to 100 gallons of water, and natural cryolite diluted with talc and diatomaceous earth reduce infestations of this pest from 67 to 80 percent, based upon the percentage of noninfested fruit produced on the treated as compared to the untreated plots. Negative or poor results were obtained with sprays containing an organic thiocyanate, cryolite, calcium arsenate, nicotine sulphate and a light oil-pyrethrum extract combination, and phenothiazine, as well as with dust mixtures containing pyrethrum, calcium arsenate, and phenothiazine. Observations on the habits of the insect show that the tomato pinworm adult favors the lower surface of the tomato leaf for egg laying. These studies indicated that 57.4 percent of the eggs were deposited on the lower surface of the leaf, 40.8 percent on the upper surface, and the remainder on the petioles. Field records show that approximately 91 percent of the pinworm-infested leaves were folded on the upper surface, which indicates the necessity of applying insecticides, if any are found satisfactory, so as to cover thoroughly the under surfaces of the leaves. Examinations in fields heavily infested by the tomato pinworm have indicated that approximately 80 percent of the larvae pupate in the top half-inch layer of soil and that approximately 98 percent of them pupate in the first inch of soil. It is apparent that the tendency of the tomato pinworm larvae to pupate very close to the soil surface may render it possible to develop some measure of control of these pests through the medium of cultural practices designed to disturb or destroy the pupal cells during critical periods. The ability of the tomato pinworm to survive under adverse conditions was demonstrated during the winter of 1936–37 when a very high percentage of survival occurred in southern California even though the longest cold spell on record prevailed in this area during January 1937, including a minimum of 22° F. and a total of 17 nights during which the temperatures at Alhambra, Calif., fell below freezing.

During the year the work on tomato fruitworm (*Heliothis obsoleta* F.) was expanded, and particular attention was given to the habits of the pest as well as to control tests. Dust mixtures containing calcium arsenate, cryolite, or cuprous cyanide have given best results in experimental plots, although none of these gave an entirely satisfactory measure of control. Derris, pyrethrum, and phenothiazine have given poor results. The importance of combating the tomato fruitworm in its early stages was substantiated by the results of laboratory experiments in California wherein it was shown that each larva of the fruitworm is capable of injuring or destroying six tomato fruits, on an average, during its larval period. The number of tomato fruits destroyed by each larva under observation ranged from 4 to 10. These studies also demonstrated conclusively that the young larvae are migratory in their habits and travel commonly from fruit to fruit during their period of larval activity. Cage studies in Utah indicated that the tomato fruitworm was unable to survive the winter of 1936–37 in that locality even though the individuals kept under observation were placed in cages under very favorable conditions during the fall of 1936 and supplied with sufficient food to enable them to reach maturity before entering the soil.

MISCELLANEOUS VEGETABLE INSECTS

Additional experimental work has shown that paradichlorobenzene is effective against larvae, pupae, and adults of the sweetpotato weevil when used to fumigate seed sweetpotatoes in banks and barrels. Preliminary experiments have indicated that the eggs of the sweetpotato weevil may be killed also during the process of paradichlorobenzene fumigation in barrels. The grade of material used and the temperatures during the fumigation period are important factors in successful fumigation. It was shown that fumigation with this material did not injure the seed or reduce plant production. Biological investigations demonstrated that the adults of the sweetpotato weevil are able to fly for a distance of at least 400 yards.

Laboratory toxicity studies on the vegetable weevil demonstrated that pyrethrum diluted with equal parts of china clay compared favorably in toxicity with undiluted calcium arsenate, but that both of these were distinctly superior to derris combinations containing 0.5, 1.0, and 2.0 percent of rotenone, respectively, and to sulphur. In field experiments directed against the turnip aphid on turnips and mustard, however, it was shown incidentally that dust mixtures containing 1 percent of rotenone, with equal parts (by weight) of finely ground dusting sulphur and tobacco dust as the diluent, and derris sprays containing approximately 0.02 percent of rotenone, with or without an alkylphenylbenzenesulphonic acid spreader and wetting agent, were effective in protecting the turnips and mustard from damage by larvae of the vegetable weevil. These insecticidal applications were begun when the plants and the infesting weevil larvae were small. They were repeated at intervals of 14 days, from four to six treatments being applied. Judging from these experiments it appears that rotenone compounds may be effective when applied to plants infested with small vegetable weevil larvae.

Observations in California upon the effect of eradicating nightshade, the overwintering host of the pepper weevil, as a control measure for this insect demonstrated that under favorable conditions this method leads to a marked reduction in infestation. Tests with several insecticides not tried previously against the pepper weevil demonstrated that phenothiazine, dibenzothiaphene, and commercially prepared combinations of pyrethrum were not as effective as calcium arsenate against the insect. Observations of commercial operations indicated that treatments of calcium arsenate applied at the proper time and in the proper manner gave commercial control of the weevil and that the latest developed washers were effective in removing the excess arsenical residues from peppers before they were dried or directly after harvest.

Investigations on mole crickets (*Scapteriscus* spp.) under Florida conditions have disclosed that their principal food consists of organic matter present in the soil, instead of living plant tissue as formerly suposed, that fresh baits are preferred to decomposed baits, that paris green in baits is definitely repellent, and that sodium fluosilicate in baits is not definitely repellent. Control experiments have also demonstrated the ineffectiveness of magnesium sulphate (Epsom salt) in baits.

A study of the seasonal occurrence in the Salt River Valley, Ariz., of several species of loopers (*Autographa* spp.), the beet armyworm, and cutworms injuring lettuce disclosed that these depredating worms do not undergo any distinct hibernating period in this territory and that all stages of these insects may be found during the year. The cool winter weather, however, retards the activities of these worms to such an extent that it usually has a distinct bearing on control measures. Fall-grown lettuce develops very rapidly, and the results of experiments with this crop indicated that one application of insecticides containing arsenicals, when the plants were small, protected such plants until they had established themselves sufficiently to overcome the attacks of the worms. Experiments in small field plots demonstrated that the organic insecticides derris and pyrethrum, applied after the lettuce had been thinned, would control the loopers but would not control the beet armyworm or cutworms.

An improvement in hand methods of parasitization of the European earwig rendered it possible to parasitize earwigs 10 times faster than heretofore, thus making available a large number of parasites (*Bigonicheta setipennis* Fall.) for reinforcing existing colonies and starting new ones. Recovery operations indicated that the parasites had spread to a distance of at least four blocks in the case of colonies liberated in the city, and to a distance of three-fourths of a mile in the case of parasites liberated in the country. In field experiments with poisoned baits for the earwig it was determined that bait containing salt in place of fish oil was not so effective as the standard bait, that bait containing sodium fluoride was almost as effective as the sodium silicofluoride used in the standard bait, and that bait containing one-half the customary dosage of sodium silicofluoride was unsatisfactory.

COLE CROP INSECTS

Investigations on cabbageworms attacking cabbage in Louisiana and South Carolina yielded definite progress in the formulation of a control program. It was found, in the instance of the spring crop of cabbage, that timely applications of a derris dust mixture containing 0.5 percent of rotenone protected the crop adequately against the common species of cabbageworms (*Autographa brassicae* Riley, *Ascia rapae* L., and *Plutella maculipennis* Curt.). Results

indicated that such applications were applied to best advantage economically during the period between the heading of the cabbage and harvest, or during the harvest period when harvest was prolonged and conditions were suitable for insect development.

In field studies to determine the economic status of the more common species of cabbageworms attacking cabbage in Louisiana and South Carolina it was found that, on an average, 41 percent of the cabbage plants failed to make marketable heads (U. S. Grade No. 1) owing to cabbageworm injury, that an aditional 23 percent failed to mature owing to causes other than worm injury, and that the remaining 36 percent produced marketable cabbage. In about half of the fields under observation the growers had applied derris dust mixtures, or paris green or lead arsenate, as well as poisoned bait for cutworms. In those fields where control measures had been practiced 30 percent of the potentially marketable cabbage plants were rendered unmarketable by worms, as compared to 74 percent in the fields where no control measures were used, thus indicating the possibilities of improved yields by insecticide applications. In this same series of studies it was shown that, under the conditions existing when these observations were made, the cabbage looper and the imported cabbageworm caused approximately an equal degree of damage, per worm, and that either species will cause about four times as much damage as an equal number of the larvae of the diamondback moth. If this relative importance of the three more important species of cabbageworms is found to persist from year to year, the importance of emphasizing the control of the two first-named species is evident.

When the physical characters of individual cabbage plants that may affect the degree of cabbageworm infestation and injury were being studied, it was indicated that such characters as undulation, bloom, and color are apparently not important but that the type of plant within varieties may exert a decided effect in attracting the moths for deposition of eggs and in the subsequent growth and survival of the resulting larvae.

Investigations of the cabbage webworm in North Carolina demonstrated that the most serious injury by this insect occurred during the seedling and transplanting stages of the host plant. Applications of undiluted calcium arsenate or of dust mixtures containing 0.5 percent of rotenone during this period of growth gave promising indications of control. The cabbage webworm failed to survive the winter of 1936–37 in North Carolina, even in the presence of unusually mild conditions.

BERRY INSECTS

Results of insecticide tests against the raspberry fruitworm in the Puyallup Valley, Wash., showed that dust mixtures containing 0.5 percent of rotenone and sprays containing 0.01 percent of rotenone were effective as a control and did not leave a harmful residue on the marketed berries; that while phenothiazine gave the best degree of fruitworm control, it injured the plants to such an extent that the yield was decreased greatly; that the use of arsenical sprays or dusts after any of the blossoms have opened may leave a poisonous residue above the tolerance limit on harvested fruit; and that late applications of insecticides gave the best control.

Continued experiments in the control of the red berry mite (*Eriophyes essigi* Hassan) in the Puyallup Valley demonstrated that the application of lime-sulphur sprays during the dormant period of the plant, followed by sprays containing wettable sulphur or emulsions of refined petroleum or coal-tar oil during the growth of the plants and up to the time when the fruit begins to ripen, results in an adequate control of this mite.

BEET LEAFHOPPER

Investigations of the beet leafhopper in the intermountain region of Colorado, Utah, Idaho, and Arizona resulted in the addition of important information respecting the critical breeding areas of this insect. Migration of this pest was traced definitely from southern Arizona breeding areas to the western Colorado beet fields. In field experiments, conducted in cooperation with beet-seed producers, pyrethrum-oil sprays directed against the beet leafhopper on sugar beets grown for seed in Arizona indicated that beneficial results were obtained from this treatment as judged by an increased yield of seed per acre. Extensive field observations indicated that the delayed planting of beans in southern Idaho decreased the severity of curly top disease, which is transmitted by the beet leafhopper. In a study of factors governing curly top in-

fection, made in south-central Idaho during the 7-year period 1930–36, it was concluded that early spring movements of the beet leafhopper were followed by rapid and widespread curly top infection, resulting in low yields of sugar beets, whereas late spring movements were followed by seasons in which sugar beets escaped serious curly top infection and produced good average yields. A comparison of the acreages of sugar beets planted, thinned, abandoned, and harvested, and the resultant yields per acre, during seasons of high curly top infection, with those of low infection, showed that much abandonment of sugar-beet acreage occurred during those years when the curly top disease appeared early in the season and spread rapidly, and that low tonnages of beets resulted, whereas very little abandonment occurred in years when curly top infection was late and slow in spreading, and that good average yields were obtained under these conditions. In comparing the average yields of sugar beets in 1935, during which resistant strains of beets were planted, with the yields obtained in 1930 and 1932, during which susceptible strains were grown, it was shown that high curly top infection reduced the average yield of susceptible beets in 1930 to a point below the margin of profit, and that low curly top infection allowed the production of a highly satisfactory average yield in the same strains of sugar beets in 1932; also, that the resistant strains of sugar beets produced a good average yield in 1935, despite a high infection early in the season.

As a result of a survey made in Texas, approximately 2,700 square miles of territory were added to the known breeding areas of the beet leafhopper. Leafhoppers from this area have been primarily responsible for the curly top disease epidemics which have been prevalent in the spinach fields of Texas. The known breeding areas of the beet leafhopper in this section now occupy approximately 10,700 square miles north of the Rio Grande in New Mexico and Texas in addition to the unknown extent of adjacent areas in Mexico.

Field observations in California indicated that the curly top disease, of which the beet leafhopper is the vector, is more prevalent in tomatoes planted in sandy soils than in those planted in soils of the heavier types, and that fields of tomatoes planted before the spring migration of the leafhoppers were infected by curly top to a greater extent than those planted after the principal leafhopper migration. Biological investigations disclosed that the beet leafhopper can exist for long periods late in the fall on various species of deciduous trees grown in or adjacent to the San Joaquin Valley, in addition to the previously known host plants of this insect. High populations of the beet leafhopper which occurred during the fall of 1936 on Russian-thistle growing adjacent to the winter breeding grounds of the insect necessitated the spraying of large areas of this weed to destroy the leafhoppers congregated thereon.

TOBACCO INSECTS

Extensive field-plot tests against tobacco flea beetles (*Epitrix parvula* F. and *E. cucumeris* Harr.) in Florida, Tennessee, North Carolina, South Carolina, and Connecticut indicated that these pests could be controlled in the plant bed, as well as on newly set plants and on the growing crop, by timely applications of dust mixtures containing rotenone derived from derris or cube, with sterilized tobacco dust as the diluent. In the wrapper-tobacco districts of Connecticut and Florida the growers have adopted dusting with cube or derris mixtures for flea beetle control, but in the flue-cured and other sun-grown tobacco areas these insecticides are not as yet recommended for general use. From data obtained to date, dust mixtures containing rotenone gave a higher initial degree of control than insecticides containing arsenical or fluorine compounds. In a series of experiments designed to show the relative toxicity of cube dust mixtures containing 0.5, 1.0, and 1.5 percent of rotenone, respectively, against the tobacco flea beetle on shade-grown tobacco in Florida, it was shown that the dust mixtures containing 1.0 and 1.5 percent of rotenone, respectively, were much more toxic and gave a higher degree of control of the flea beetles than the dust mixtures which contained 0.5 percent of rotenone. These conclusions were reached as a result of a detailed study of the harvested product, in which it was shown that the percentages of injured leaves, together with the percentages of the commercial gradings, served as a satisfactory method for obtaining a relative comparison of the effect of the different dilutions used. Incidentally, these studies demonstrated that a flea beetle infestation of only moderate intensity may cause a loss, based on an average crop return in cigar-wrapper tobacco, which reaches $475 per acre.

Laboratory studies to determine the comparative toxicity of certain arsenicals and nonarsenical compounds to the larvae of tobacco hornworms (*Protoparce*

spp.) showed that none of the arsenicals now available were more toxic than the paris green-hydrated lime dust mixture which is now advocated for combating these insects. A satisfactory substitute for paris green and other arsenicals has not been found among the organic compounds tested.

Experiments in tobacco warehouses of the closed type in Virginia showed that dusting with pyrethrum was a very effective method of combating the adults of the tobacco moth. A reduction of approximately 97.5 percent in the population of this insect was obtained in warehouses where this method of control was utilized.

GREENHOUSE AND BULB INSECTS

During 1936 it was found that gladiolus corms infested by the gladiolus thrips lost weight during the storage period faster than noninfested corms, and that, after planting, the infested corms were retarded and made an uneven growth; also, that the blooming of such corms was delayed and subsequent corm production reduced greatly as compared with noninfested corms. Although many different spray combinations were tested against the gladiolus thrips, the arsenical-brown sugar combinations gave the best degree of control. With the possible exception of lead arsenate, however, such combinations burned the foliage rather severely.

Observations at Charleston, S. C., on the insect vectors of the azalea flower spot disease revealed that insects did not bring the organism causing this disease into gardens or nurseries to cause infection on the flowers appearing early in the season. The appearance of the earliest infections on flowers close to the ground indicated that the soil or mulch may be the hold-over source between flowering seasons. It was found that with the increase in the number of insects that visited azalea flowers, notably several species of bees (*Bombus* spp.), a decided increase occurred in the local spread of the disease on all parts of the azalea plants. The percentage of infective insects increased in the daily collections as the disease became more prevalent. Evidence was obtained that insects could carry azalea flower spot infection for a distance ranging from 1 to 5 miles.

A high percentage of the common red spiders were killed on greenhouse-grown lima beans and sweetclover by spraying with an organic thiocyanate applied under 300 pounds of pressure. Similar results were obtained by dipping strawberry plants infested by the red spider in an organic thiocyanate spray mixture or in a water suspension of derris.

MUSHROOM INSECTS AND MITES

Tests made against various species of mushroom flies (*Sciara* spp.) and other pests in the mushroom houses at Beltsville, Md., demonstrated that free nicotine (40 percent) in water at dilutions of 1 to 100 and 1 to 200 (containing 0.4 and 0.2 percent of free nicotine, respectively), applied as a drench to the mushroom beds at the rate of 100 cc per square foot, gave a promising degree of control of the flies and other pests and caused a marked increase in the production on the beds receiving this treatment. Beds treated at 4-day intervals with a total of five or six treatments yielded approximately one-third more mushrooms than those treated at 8-day intervals and gave approximately twice the yield of the untreated beds. Analysis of the mushrooms treated with the free nicotine solutions showed that the highest nicotine content of any sample was 29 parts per million by weight, a quantity not believed to be harmful to the consumer. Paradichlorobenzene, when used as a fumigant at the rate of 1 pound per 1,000 cubic feet of air space for an exposure period of 48 hours, gave good control of sowbugs but did not control mites (*Tyroglyphus* spp.) or springtails (*Lepidocyrtus* spp. and *Achorutes* spp.). Taxonomic studies indicated that the most common species of mushroom mite in the United States may be a different species than was formerly recorded.

COTTON INSECT INVESTIGATIONS

In February 1937 the station at Tlahualilo, Durango, Mexico, was discontinued. This station was established before there was opportunity to conduct pink bollworm investigations in the United States, but since these investigations may now be conducted in the vicinity of Presidio, Tex., where this Bureau has a station, the special need for a station in Mexico no longer exists.

During the spring of 1937 investigations were begun at five new seasonal field stations. Investigations of boll weevil control on sea-island cotton were started in Alachua County, Fla., in cooperation with the Florida Agricultural Experiment Station, in McIntosh County, Ga., in cooperation with the State

entomologist of Georgia, and in Echols County, Ga., in cooperation with the Georgia Coastal Plain Experiment Station. In Arizona, in cooperation with the Arizona Agricultural Experiment Station, studies were begun at Mesa and Yuma on the control of hemipterous insects. For the work at Yuma, headquarters were established at the Bureau of Plant Industry field station at Bard, Calif.

BOLL WEEVIL

The year 1936 was notable because of the comparatively small damage caused by the boll weevil, the losses by this insect being less than during any year since 1925. This unusual condition was caused by the low boll weevil population entering hibernation in the fall of 1935, by the low temperatures that caused high mortality among the hibernating weevils during the winter, and by the high temperatures and drought conditions during the 1936 growing season in the States east of Texas. The weevil caused its greatest damage in Texas. In eastern and southern Texas there was a higher survival of weevils in the spring of 1936; weather conditions were favorable for their development throughout the season, and for the first time in many years the weevils caused a greater reduction in yield per acre in Texas than in any other State. The low winter temperatures caused the lowest survival in 1936 ever recorded in the hibernation cages at Florence, S. C., and no survival in the cages at Eufaula, Okla. The survival of weevils was much lower than normal at Tallulah, La., but at College Station, Tex., it was several times higher in 1936 than usual. The generally low survival over most of the Cotton Belt was followed by a very dry spring, with extremely high temperatures in May and June, which further reduced the number of weevils, except in eastern Texas. The drought was more prolonged in Oklahoma, where only 2.11 inches of rain fell in the 99 days from June 8 to September 14, 1936, and the weevil infestation was practically wiped out. At Tallulah, La., approximately 90 percent of the grubs in the infested squares were killed by climatic conditions during the latter part of June. As a result of the low survival and climatic control, the infestation did not build up until late in the season, and in many sections no control measures were necessary. This low weevil population over most of the Cotton Belt was followed by an early and widespread infestation of leaf worms, which defoliated the cotton early and further reduced the weevil population that entered hibernation in the fall of 1936.

The winter of 1936–37 was mild, and in the boll weevil hibernation experiments at Florence, S. C., the survival was much higher than during any spring since 1933; at Tallulah, La., it was higher than in any spring since 1932, and at College Station, Tex., the survival of weevils was highest of any year since the experiments were started 6 years ago. Although in most areas the weevil mortality was low during the winter of 1936–37, the number of weevils present in the cotton fields in the spring of 1937 depended chiefly upon their abundance during the fall of 1936. At Florence the weevils were more abundant early in 1937 than during any year since 1932. In Florida, southern Georgia, and Mississippi the weevil population was low. At Tallulah it was lower than during any recent year except 1936. Cage experiments and field observations indicated that many weevils emerged later from hibernation than usual. During the early season of 1937 conditions were not particularly favorable for the weevils, and at midsummer the prospects were that 1937 would be another light boll weevil year except in the South Atlantic and eastern Texas areas.

Mixtures of calcium arsenate and sulphur used for boll weevil control have in some experiments given greater gains in the yield of seed cotton per acre than undiluted calcium arsenate. These increased yields probably result from additional control of the cotton flea hopper and other hemipterous insects by the sulphur. These experiments indicate progress in developing an economical insecticide that will give practical control against the boll weevil, flea hopper, and other insects at the same time.

Mixtures of calcium arsenate and lime have in many instances given more profitable increases in yields than undiluted calcium arsenate. These mixtures have the advantage of reducing the dangers of soil injury and of heavy aphid infestation, and at the same time reducing the cost of weevil control. Although the tests in which the lime-calcium arsenate mixtures have given better results than undiluted calcium arsenate have been in the presence of comparatively light boll weevil infestations, this has been the normal condition in the boll weevil area during recent years.

In cage tests at Tallulah, La., with 20 different brands of calcium arsenate ranging from 11.2 to 0.2 percent in water-soluble arsenic pentoxide, as determined by the New York method, the boll weevil mortality ranged from 39 to

92 percent. There was apparently no correlation between boll weevil mortality and percentage of water-soluble arsenic pentoxide, or between the mortality and any of the chemical and physical characteristics of the calcium arsenates, such as free lime, molecular ratio, and particle size. Just what differences in method of manufacture or what physical or chemical qualities of the calcium arsenate cause this difference in toxicity has not been discovered.

SOIL INJURY FROM CALCIUM ARSENATE

The injurious effect to certain crops following the use of calcium arsenate in boll weevil control was first observed in eastern South Carolina more than 10 years ago. In general the soils where injury was noticeable were light, sandy soils of low fertility, and the most striking cases of injury were in fields where more than normal amounts of calcium arsenate had been used. The crops most seriously affected were the legumes, such as cowpeas and soybeans, oats, and to a less degree cotton. Although no cases of soil injury have ever been reported or observed in the Delta sections of Louisiana and Mississippi, where calcium arsenate dust has been used for boll weevil control more extensively and for a longer period than anywhere else, an experiment was started at Tallulah in 1931 by applying calcium arsenate to one plot of soil at the rate of 400 pounds per acre and comparing the crops planted on it with the crops on the adjacent plot that had not received any calcium arsenate. The applications of calcium arsenate were continued annually for 5 years or until a total of 2,000 pounds per acre had been applied, an amount in excess of what would be applied in 100 years for boll weevil control under ordinary farm practices. The average yield for the 6-year period since the experiment was started was 1,827 pounds of seed cotton per acre for the treated plot and 1,826 pounds for the untreated plot. So far as cotton production on this Delta soil is concerned there seems to be no danger from the continued use of calcium arsenate. However, soybeans and cowpeas are seriously affected by large quantities of calcium arsenate on this soil, as most of the plants soon died on the treated plot.

In Mississippi the study of the effect of calcium arsenate on seven major soil types and crops grown on them has been continued. Plots of each soil type received calcium arsenate at the rate of 50, 100, 200, 400, 800, and 1,600 pounds per acre in April 1935, and no arsenic has been added since that date. The germination and survival records for corn, cotton, and soybeans in the spring of 1937 show less injury than in the 2 preceding years. The same is true for the winter crops, Austrian Winter peas, hairy vetch, and oats. The yield of cotton and corn has not been materially reduced on any of the seven soils except where applications of 1,600 pounds of calcium arsenate per acre were made. The yields of Austrian Winter peas, oats, vetch, and soybeans have been reduced where 800 and 1,600 pounds of calcium arsenate per acre were applied. The effect of excessive quantities of calcium arsenate varied considerably with the different soil types. The Houston soil, black clay from the prairie section, is the most resistant to arsenical injury; and the Norfolk and Cahaba, light-colored, sandy soils are the least resistant. The yields and plant survival records indicate that the soils are recovering from the arsenical injury. Chemical analyses of the different soils treated with varying dosages of calcium arsenate showed that the range in decrease of water-soluble arsenic from 1935 to 1936 was from 23 percent to 80 percent. The maximum quantity of arsenic (As_2O_3) found in corn, cotton, and soybean plant grown in the arsenic-treated soils was 5.8, 10.0, and 8.0 parts per million, respectively.

COTTON FLEA HOPPER

Better control of the cotton flea hopper was again secured at Port Lavaca, Tex., by dusting with mixtures of arsenicals and sulphur than with sulphur alone. Mixtures of 10 percent of paris green and 90 percent of sulphur and of 20 percent of calcium arsenate and 80 percent of sulphur were about equally effective, and both mixtures gave much better control than sulphur alone. Excessive rains during the latter part of June and July in 1936 caused the cotton to shed the greater part of the bolls and considerably reduced the yield, but even with adverse conditions profitable gains were made by controlling the flea hopper. As the mixtures of arsenicals and sulphur are also of value against the boll weevil, leaf worm, and other cotton insects, it is expected that their use will reduce the cost of control where several insects occur together. Further experiments are needed to determine the best proportions of arsenic and sulphur to use under different conditions. Since the finding last year of the two cotton flea hopper egg parasites *Anaphes anomocerus* Gir. and *Erythmelus*, n. sp., studies have been continued of their distribution, abundance, and life

history. The more abundant and important parasite, *Erythmelus* sp., has been found to occur in Arizona, Arkansas, Louisiana, Mississippi, and South Carolina, and in 36 counties in Texas. *A. anomocerus* has been bred from flea hopper eggs only from Arizona and Texas. An average of 25 percent of the 11,000 flea hopper eggs in the stems of croton plants collected in six States last year were parasitized. The information secured to date indicates that *Erythmelus* passes the winter within the overwintering eggs of the flea hopper and also parasitizes the eggs of other mirids.

PINK BOLLWORM

The introduced parasites *Microbracon brevicornis* Wesm. and *Exeristes roborator* F. apparently did not become established in Texas or Mexico after liberations over a 3-year period. The latter species, however, appears to be established in Puerto Rico, and further breeding and liberations of these species were discontinued. Recoveries of *M. kirkpatricki* Wilk. and *Chelonus blackburni* Cameron have been made near the points of liberation in Texas, Mexico, and Puerto Rico, and although establishment is not certain, the prospect is encouraging and further liberations will be made. In the Presidio Valley, Tex., the Hawaiian strain of *M. mellitor* Say was recovered following initial releases last season, but its present status is undetermined.

Further studies of the native parasites occurring in Mexico have shown that one species of Diptera and at least four species of Hymenoptera, and possibly others, attack the pink bollworm. These native parasites are becoming of increasing importance, although they do not exercise sufficient control to prevent heavy annual infestations and damage. Technique for laboratory rearing of *Microbracon platynotae* Cush. and *Perisierola cellularis* var. *punctaticeps* Kieff. were developed, and small liberations were made to study the possibility of increasing their effectiveness. The former species was found to breed on an undescribed lepidopteron which occurs abundantly on blue weed (*Helianthus ciliaris*).

Three screened insect-proof field cages covering approximately 1 acre of land were completed and placed in use at Presidio, Tex., to prevent the movement of moths from surrounding fields from interfering with experiments to secure more definite information on the effect of cultural practices on the control of the pink bollworm. Additional tests with several quick-maturing eastern varieties of cotton again demonstrated that the damage from the pink bollworm in heavily infested areas can be considerably reduced by the selection of proper varieties, and by cultural practices such as close spacing and controlled irrigation, which hasten maturity and reduce the late seasonal damage and the build-up of the fall population which goes into hibernation. Although no resistance to the pink bollworm was evident in the varieties of cotton tested and all of them became 100 percent infested, there were indications that the grade of the lint was not lowered as much in the varieties with a high percentage of lint as in the varieties with a low percentage. In cage tests with cotton growing under controlled conditions, barium fluosilicate dust gave the greatest reduction in the number of worms per boll of any of the insecticides tested. Satisfactory control has not been secured with any of the materials tested, and further tests with this and other fluorine materials are in progress.

Several species of malvaceous plants were found to be hosts of the pink bollworm in Puerto Rico, but only the seed pods of the two trees *Montezuma speciosissima* and *Thespesia populnea* are considered important in providing a continuous supply of food for breeding during the closed season for cotton. It was definitely established that long-cycle larvae occur in Puerto Rico, the resting period of which may last for several months under dry conditions but is materially shortened under favorable moisture conditions. These studies are of practical importance in reducing the damage to cotton by proper adjustment of the planting dates to the rainfall distribution, and the local authorities have modified the regulations so as to prescribe uniform planting and closed seasons for the entire island instead of different seasons for the northern and southern parts of the island.

COTTON LEAF WORM

The cotton leaf worm made its appearance in southern Texas early in May 1936 and reached all cotton States except California before the end of the season. Although large quantities of arsenical poisons were used to control it, considerable damage was done in regions where it appeared early. Some regions were not reached until after the crop was mature, and the defoliation of the cotton plants greatly reduced boll weevil population to enter hibernation

in the fall of 1936, which partially accounts for the light boll weevil infestations in many areas at the beginning of the 1937 season.

In Oktibbeha County, Miss., the leaf worms appeared late in July; and about August 20, when the second generation of worms began to strip the plants, two tests were conducted to determine the amount of damage caused to the crop by the leaf worms. In these tests the average gain from dusting was 288 pounds of seed cotton per acre, the cost of treatment was $2.18, and the profit was $10.39 per acre. The increased production was due in part to the development of heavier bolls on the plants that had not been defoliated.

THRIPS

Thrips were reported from practically all cotton-growing States as especially injurious to seedling cotton during 1936. The extremely dry season was favorable for the increase of thrips. The most extensive damage to cotton occurred in the Southeastern States.

In Cullman County, Ala., during June a large proportion of the cotton plants on several thousand acres were defoliated by thrips. A series of tests with cube, nicotine, and pyrethrum as dusts and paris green and nicotine as sprays was conducted, but no noticeable control was obtained with any of them. With few boll weevils present and favorable seasonal conditions for cotton following the serious thrips outbreak in this region, a good yield of cotton was produced even though it was delayed 15 to 20 days by the heavy thrips infestation during June. In Washington County, Miss., a study of thrips injury to 40 commercial varieties of cotton revealed no difference in varietal infestation, but it was found that early chopping and allowing a greater number of stalks to remain in the hill decreased the percentage of terminal buds damaged. Destruction of the terminal buds caused a loss in seed-cotton production in 34 out of 40 varieties and a loss in staple length on damaged plants of 7 varieties. Several species of thrips were involved in injury to cotton.

HEMIPTEROUS INSECTS

Further studies on the complex problem of damage to cotton in Arizona by hemipterous insects confirmed previous results that the most injurious species are three stinkbugs of the family Pentatomidae, viz, *Euschistus impictiventris* Stål, *Chlorochroa sayi* Stål, and *Thyanta custator* F. All of these feed on the bolls and cause shedding, but the most noticeable injury is the lowering of grades caused by staining of the lint by pathogenic organisms which follow the puncturing of the bolls. The damage was greatest in Yuma County and lightest in Pima County, the average of bolls punctured in Arizona being 24 percent in 1936 as compared with 27 percent in 1935 and 23 percent in 1934.

Experiments in control with insecticides made on a field basis with power dusting machines gave promising results but were not conclusive as to the most effective insecticide combinations and methods of application. Population counts of hemipterous cotton insects were made throughout the season on crops and weeds to secure information concerning the host-plant relationships of the different insect species in connection with their migrations to the cotton fields.

THURBERIA WEEVIL

Studies over a 10-year period on the life history and habits of the Thurberia weevil when removed from its native host, *Thurberia*, and bred exclusively on cotton indicate that this weevil will not maintain itself on cultivated cotton under the usual cultural practices followed in southeastern Arizona. Experiments and observations show that where the stalks are destroyed in the fall and the usual irrigation practices applied it can be exterminated in 1 year where reinfestation from *Thurberia* plants does not occur. In the vicinity of natural infestation, where the weevil readily transfers from *Thurberia* to cotton, the infestation was greatly reduced by destruction of the *Thurberia* plants for a distance of 1 mile from the cultivated area. It appears that the greatest danger from the Thurberia weevil would be its introduction to sections with more favorable climatic conditions where the boll weevil occurs, as it interbreeds with the latter and might produce a biological race more resistant than the boll weevil to hot, dry weather and low temperatures.

BOLLWORM

In experiments for controlling the bollworm by insecticides, special attention was given to determining if the dusting schedule could be simplified by making a definite number of applications at fixed intervals. With the heavy bollworm infestations that prevailed in eastern Texas last season the best average in-

creases in yield were secured with four applications of calcium arsenate at 5-day intervals, beginning shortly after the first egg deposition on cotton. Calcium arsenate gave more effective control than a mixture of 90 percent of sulphur and 10 percent of pyrethrum, while the tests on increasing the arsenical content of calcium arsenate by adding 5 or 10 percent of paris green and on decreasing the arsenic by mixing with lime or sulphur were inconclusive.

In hibernation cages the number of moths emerging from overwintering pupae was greater in well-drained Lufkin fine sandy loam and Norfolk fine sand than in Blackland or Brazos River bottom soils; the differences in survival were not so great, however, where the soils were more moist.

PINK BOLLWORM CONTROL

The more important developments in the pink bollworm situation during the 1936 crop season were the finding of a new infestation in the lower Rio Grande Valley in both Texas and Mexico; the finding of reinfestation in several additional counties in the Texas Panhandle after a lapse of several years; and no recurrence of infestation in northern Florida for the second consecutive crop season.

The infestation in both of the above areas is very light. In the lower Rio Grande Valley of Texas four counties are involved, and they were placed under regulation on August 17, 1936. In the Texas Panhandle five counties are involved; a portion of two of the counties, however, was already in the regulated areas. This new territory was placed under regulation effective December 1, 1936. In both of the above instances it was necessary to include one or more counties in which no infestation was found. This was due to the fact that seed cotton is moved through such counties for ginning without regard to county lines. The Florida area was released from regulations effective October 14, 1936.

NEW INFESTATION IN LOWER RIO GRANDE VALLEY

The harvesting of the cotton crop in the lower Rio Grande Valley takes place much earlier than in any other section of the Cotton Belt. On August 6, 1936, gin-trash inspection was begun at Matamoros, Mexico, just opposite Brownsville, Tex. In the first sample of trash inspected specimens of the pink bollworm were found. Thereafter worms were found almost daily in trash from all gins in the Matamoros section until August 15, at which time inspections were discontinued. A total of 235 pink bollworms were submitted for identification, in addition to some 20 or 25 worms which were turned over to Mexican agricultural inspectors at their request. At Reynosa, Mexico, about 50 miles up the river from Matamoros, eight specimens of the pink bollworm were found, the first on August 12. These are the only two locations on the Mexican side of the river at which gins were operated. In the meantime, following the first finding at Matamoros, additional gin-trash machines had been sent to the valley to work on the Texas side. These machines began operating on August 10, 1936, and on the following day the first specimen of the pink bollworm was found at Brownsville. During the next few days three additional specimens were found at that place. On August 12 the first specimen was found at San Benito, and when inspections had been completed 19 specimens had been found at that location, but later in the season several additional specimens were found by regulatory inspectors. Both of the above places are in Cameron County. The only other finding in the valley was at Rio Grande City, Starr County, one pink bollworm being found on August 15.

On August 17, 1936, the pink bollworm quarantine was amended to add the counties of Cameron, Hidalgo, Starr, and Willacy to the lightly infested areas. While no specimens were found in Hidalgo and Willacy Counties, it was necessary to include them, as seed cotton is moved throughout the four counties for ginning without regard to county lines. Approximately 250,000 acres were planted to cotton in the four counties.

When the area was brought under regulation the bulk of the cotton crop had already been harvested. There was only one oil mill in the area, consequently a considerable volume of seed was moving to other mills in southern Texas. Immediately after the first specimen was found no seed was allowed to leave the valley until several mills which desired to continue receiving seed installed sterilizers, after which the seed was allowed to move to these mills, and immediately upon arrival was heated to 155° F. The lint was compressed at the two plants in the area or allowed to move to designated plants at Corpus Christi for treatment. It should be stated that all persons and firms involved cooperated wholeheartedly in carrying out the above treatment, even though no regulations were in effect when they were first begun.

Plans for enforcing the regulations during the coming season are somewhat different from those followed in the past. Instead of installing sterilizers at each gin, large central plants have been built at various points in the area. All seed for milling purposes will be treated at these plants, and after it has been heated to 155° F. it will be allowed to move to any point. Seed for planting will be stored in suitable places and, after the ginning season is completed, will be sterilized by the State. All seed, either for milling or planting, must be sterilized by October 1. A simple permit system is used whereby we have knowledge at all times of the amount of unsterilized seed remaining in the district and the person who has the seed. The harvesting of the 1937 crop got under way about the middle of June, and a number of the large central sterilization plants have been operating very satisfactorily.

The cotton crop is planted the latter part of January and in February. Picking and ginning begins the latter part of June and is largely completed by the end of August. Because of the mild climate cotton plants are seldom killed by frost, but remain alive throughout the fall and winter. Thus under usual conditions there would be plenty of fruit to maintain the pink bollworm throughout the year. The State has issued regulations that cotton stalks are to be destroyed after the harvesting season and not later than October 1. There will thus be no material on which the insect can propagate itself during a period of some 6 or 7 months. Another point in favor of this plan is that it will undoubtedly be of considerable advantage in reducing boll weevil carry-over. Farmers, ginners, and other influential citizens are greatly interested in the plan, and indications are that it will be carried out satisfactorily.

SITUATION IN OLDER REGULATED AREAS

The status of infestation is determined by laboratory inspection of green bolls if possible; otherwise by gin-trash inspection. If infestation can be established by laboratory inspection, gin-trash machines can thus be released for work in other areas. In some of the very lightly infested areas this cannot be done and it is necessary to do gin-trash inspection each season. In the regulated area of northern Florida intensive gin-trash inspections were carried on and practically all trash produced was inspected. By the middle of October ginning was largely completed; and in view of the thorough inspections carried on with negative results, and the negative results the previous season, the area was released from quarantine restrictions on October 14, 1936. In the Texas Panhandle results had been negative the previous season, and intensive gin-trash inspections were made this year. At three different points a total of nine pink bollworm specimens were found, indicating that an extremely light infestation still existed. In the remaining areas it was found that the status of the infestation was about the same as the previous year.

A summary of the amount and results of the various kinds of inspection is given in table 15.

TABLE 15.—*Summary of inspections for the pink bollworm in regulated areas, crop season of 1936*

District	Gin trash		Field		Laboratory	
	Bushels	Pink bollworms	Man-days	Pink bollworms	Samples	Pink bollworms
Northern Florida [1]	3,370	0	89	0	0	0
Lower Rio Grande Valley, Tex.[2]	3,922½	29	34	0	171	1
Texas Panhandle [3]	10,986½	9	4½	0	84½	0
Pecos Valley, N. Mex	434	20	0	0	132	0
Pecos Valley, Tex	10	22	0	0	62	0
Big Bend, Tex	0	0	0	0	20	8,485
Hudspeth County, Tex. (southeastern part)	0	0	0	0	28	942
El Paso Valley, Tex	5½	8	0	0	289	138
Mesilla Valley, N. Mex	53	15	0	0	330	5
Tularosa, N. Mex	0	0	0	0	0	0
Deming, N. Mex	0	0	0	0	0	0
Duncan Valley, Ariz. and N. Mex	28	0	0	0	38½	2
Safford Valley, Ariz	394	37	0	0	51	0
Tucson, Ariz	1,368	(4)	0	0	0	0
Total	20,571½	140	127½	0	1,206	9,573

[1] Released from regulations Oct. 14, 1936.
[2] Placed under regulation Aug. 17, 1936; part of gin-trash inspections made before that date.
[3] Previously listed as Western Extension.
[4] Results negative for pink bollworm, but 25 Thurberia weevils found.

INSPECTION OUTSIDE REGULATED AREAS

In planning the inspection program the most attention is, of course, given to areas most likely to become infested. Therefore intensive gin-trash inspections were carried on in southern Alabama and Georgia adjacent to the regulated area of Florida; also in the territory adjacent to the newly infested area in the lower Rio Grande Valley of Texas and in the territory adjacent to the Texas Panhandle regulated area. In the latter case three specimens of the pink bollworm were found, two in Howard County and one in Dawson County. This is the first finding in Howard County since the 1927 crop. These two counties, together with three adjoining ones, were added to the regulated area on December 1, 1936. A considerable amount of gin-trash inspection was also done in the Salt River Valley, Ariz., where an infestation was eradicated several years ago. Gin-trash or laboratory inspections are carried on as often as possible in all of the cotton States.

A summary of the various kinds of inspection and amount of material, together with the results, is shown in table 16.

TABLE 16.—*Summary of inspections for the pink bollworm outside regulated areas, crop season of 1936*

State	Gin trash		Field		Laboratory	
	Bushels	Pink bollworms	Man-days	Pink bollworms	Samples	Pink bollworms
Alabama	10,016	0	0	0	0	0
Arizona	4,937	0	0	0	0	0
Arkansas	304	0	0	0	0	0
California	1,879	0	0	0	0	0
Florida	795	0	0	0	0	0
Georgia	6,832	0	0	0	0	0
Louisiana	448	0	0	0	586	0
Mississippi	921	0	0	0	375	0
Missouri	4	0	0	0	0	0
New Mexico	0	0	0	0	9	0
Oklahoma	0	0	0	0	671	0
Tennessee	386	0	0	0	0	0
Texas	22,200	3	11½	0	1,007	0
Total	48,722	3	11½	0	2,648	0
Mexico:						
Baja California	1,024	0	0	0	0	0
Chihuahua	6¼	5	0	0	0	0
Nuevo Leon	1,460	0	3	0	0	0
Sinaloa	6½	0	0	0	0	0
Sonora	156	0	0	0	0	0
Tamaulipas	393½	243	0	0	0	0
Total	3,046¼	248	3	0	0	0
Grand total	51,768¼	251	14½	0	2,648	0

CONTROL PROGRAM IN THE BIG BEND AREA OF TEXAS

By the 1932 crop season a very heavy pink bollworm infestation had developed in the Big Bend area of Texas. This constituted a very great danger, in that infestation might spread to the Cotton Belt. Therefore, in order to reduce the infestation and eliminate the danger of spread, a special control program was put into effect. This, briefly, consisted in thorough clean-up of cotton fields in the fall; the delayed planting of the cotton crop the following spring, so the peak of moth emergence would pass before cotton began fruiting; and the use of small plots of cotton to trap the later emerging moths. The program was carried on each year and very good results were being obtained. As the large worm population was reduced the farmers began making a better top crop. They naturally wanted to harvest this, and as a result fields were not ready for cleaning before worms began going into the ground in the fall to hibernate. There was some dissatisfaction over the delayed planting date of April 15. In the fall of 1936 farmers as a rule made

no effort to get their fields ready for cleaning, and indicated that they were going to plant cotton in the spring of 1937 before April 15. For this reason the control program has been abandoned, at least for the present.

The first cotton of the 1937 season was planted on March 17, and plantings were continued after that, with the last cotton being planted on May 26. Owing to the mild winter, considerable stub or volunteer cotton came up, and in one instance a 2-acre field of stub cotton is being cultivated. By the middle of May specimens of the pink bollworm could be found in small squares in this stub cotton. This is the situation in Presidio County. In Brewster County there is a very small cotton acreage and it is all controlled by one man, who is cooperating fully in continuing the program. A thorough field cleaning was made on this small acreage last fall, and no cotton was planted this spring until after April 15. The situation in the two counties should thus provide an excellent opportunity for a thorough test of the control program, and especially the value of early or late plantings.

WILD COTTON ERADICATION IN SOUTHERN FLORIDA

The eradication of wild cotton in southern Florida was begun in 1932 to eliminate a rather heavy pink bollworm infestation, and thereby remove this menace from the main Cotton Belt. The work has been continued each year since, but because of climatic conditions the most effective work can be done only during the fall, winter, and early spring. This season five small crews began work on the west coast in August 1936. The object was to remove seedling plants which would have fruited before regular eradication work got under way in the fall. Larger crews began work about the first of November, and as weather conditions were favorable excellent progress has been made. The work was carried on largely with W. P. A. funds; some Bureau funds, however, were used at the beginning of the season. A first clean-up was made on some 130 acres, on which 4,014 mature and 12,633 seedling plants were removed. During the recleanings 2,206 mature, 1,629,975 seedling, and 21,249 sprout plants were removed. At each recleaning there has been a notable decrease in the number of plants destroyed, indicating that progress is being made toward final eradication. For example, there was a decrease of 94 percent in the number of mature plants removed this season, 42 percent for seedlings, and 63 percent for sprout plants, as compared with last season. This is especially true along the west coast and is of most importance because this area is nearest to cultivated cotton. Since the work has been under way approximately 10¼ million wild cotton plants have been destroyed.

During previous seasons wild cotton bolls have been inspected as plants were destroyed, so as to obtain information regarding the status of infestation. As the work progresses fewer bolls are encountered, and this season, instead of inspecting the bolls in the field, they were preserved and sent to Miami to be inspected after eradication work was discontinued. Inspection of this material had just gotten under way at the end of June and a few specimens of the pink bollworm had been found. These were from bolls collected on keys off the coast of Monroe County, and are farthest removed from domestic cotton.

An important phase of wild cotton work was a survey made with an autogiro during March and April 1937. The autogiro was loaned to this project by the Dutch elm disease project. An area of some 1,900 square miles was covered during the survey, and as a result 24 new locations capable of sustaining wild cotton were located. These locations were charted on a map, and it will be a fairly simple matter for clean-up crews to reach them and destroy any cotton that might be present. Of equal importance is the fact that many hundred square miles of swamp and everglades have been found to be unsuitable for wild cotton growth, and can now be eliminated from further consideration in the eradication program.

THURBERIA WEEVIL CONTROL

In the area regulated because of the Thurberia weevil in southern Arizona approximately 6,000 acres were planted to cotton this season. Of this amount some 5,000 acres are of the short-staple variety and 1,000 acres of the Pima or long-staple variety. The inspection of gin trash indicated a light infestation of the Thurberia weevil in the cultivated cotton, 25 specimens being found.

The majority of the cotton acreage is in the Marana section, about 18 miles northwest of Tucson. Most of the specimens came from the small acreage south of Tucson.

The native host of the Thurberia weevil is *Thurberia thespesioides* Gray, a malvaceous plant closely related to cotton. This plant occurs in a number of mountain ranges in southern Arizona, particularly the Tortollita and Santa Catalina Ranges, which are nearest to the cultivated cotton, and the infested plants furnish a continuous source of reinfestation to the cultivated cotton. In 1935 emergency relief funds were provided by the W. P. A. to attempt eradication of the plants and thus remove the menace from cultivated cotton. Active work was begun in August 1935 and has been continued throughout the present fiscal year. Work in the Tortollita Range was completed early in 1936, and since that time work has been carried on in the Santa Catalina Range. In the beginning the laborers were transported in trucks to and from Tucson each day. As soon as all of the area readily accessible from Tucson had been worked it was necessary to establish a camp in the mountains. The camp had to be moved several times as various sections were completed. During the fiscal year 65,245 acres were worked in the Santa Catalina Range and 562,488 *Thurberia* plants destroyed. Many of these plants were heavily infested with the Thurberia weevil. Since the work has been under way over 1,000,000 *Thurberia* plants have been destroyed.

BEE CULTURE

This season 400 packages of bees have been under observation in the apiaries of cooperators in a continuation of the supersedure study. In last season's work, of 606 queens for which complete records have been compiled, 8.26 percent were lost in shipment or by other manipulations, 8.99 by supersedure, and 3.3 percent were replaced by the beekeeper within 2 months after receipt! This indicates that the country's annual loss of queens may be as high as 20 percent from the foregoing causes alone. During the preceding season it was found that supersedure is little influenced by a variation in population of a colony such as that occasioned by adding brood or bees. During the current season the effect of the availability of pollen is being observed. So far the shipping of queens, either in mailing cages or in packages of bees, appears to have no effect on the amount of supersedure.

Preliminary work indicates that with proper equipment, good management, stimulative feeding, and an early pollen supply, good colonies in the South can produce at least 20 pounds of package bees in one season.

With the cooperation of the Vanderbilt Medical School it was found that vitamin E is not present in royal jelly. The vitamin A and B content is now being studied in a continuation of the endeavor to find why queen and worker become differentiated from each other.

Beekeeping in the Sierra Nevada and Cascade Mountains has been subjected to serious losses by bears. With the cooperation of the Zoology and Agricultural Engineering Departments of the University of California, an electric fence charged from a battery has been devised that has worked successfully in keeping bears out of apiaries when a good ground was provided for the electric current.

Cooperative work with the Oregon Agricultural Experiment Station showed that nectar from floral nectaries of various vetches under observation contained a lower sugar concentration than did nectar from the extrafloral nectaries of the same plants. For this reason bees ignored the blossoms in favor of the extrafloral nectaries. Hairy vetch proved an exception, since the sugar concentration of nectar from the blossoms was higher than that from the extrafloral nectaries. Consequently bees worked the flowers of this plant. The sugar content of nectar from alsike and crimson clovers compared favorably with that of vetches in blossom at the same time. Nectar from red clover was scarce and of a low sugar concentration not attractive to bees.

Work was begun on testing various races and strains of bees for resistance to American foulbrood by the inoculation of colonies with definite dosages of the causative organism. Thirty-nine queen bees from stock held to have shown some degree of resistance were accumulated in 1936 and 12 of them were tested in colonies. Four showed more or less indication of resistance since they cleaned up the slight amount of disease developing as a result of inoculations.

The standard dose being used for the inoculation tests consists of 10 times the minimum infectious dose or 500,000 spores per cubic centimeter in 1 liter

of sugar sirup. To facilitate the preparation of this solution, a method has been devised for preparing in powdered form measurable quantities of approximately known numbers of spores of *Bacillus larvae*. Cultural studies of various strains of the organism have shown wide variation in length of the incubation period and in the greatest dilution that will give growth in culture.

Losses of queens shipped under present standards are too high, particularly during hot weather. Provision for a continuous water supply has given promise of reducing such losses, while for queens caged for long periods, pollen added to the queen-cage candy in addition to a water supply has been shown to be beneficial in preliminary tests.

It has been found that relative humidity has a more marked effect on the longevity of caged bees than any other environmental factor. Relative humidities of about 20 to 25 percent, together with 50-percent sucrose solutions in water and with additional water available, provide satisfactory conditions for caged bee studies. The most suitable temperature conditions have not been determined, but the length of life at temperatures of 84° to 93° F. is sufficiently long for most comparative testing.

Studies on the lethal effect on bees of arsenicals used as insecticides show that a dose containing only 0.05 to 0.10 microgram of elemental pentavalent arsenic is sufficient to cause a significant shortening of life. The work also indicates that calcium arsenate ($Ca_3(AsO_4)_2$) is somewhat more toxic to bees than acid lead arsenate ($PbHAsO_4$).

Preliminary crosses and backcrosses of the Italian and Carniolan races by the Watson method of artificial insemination gave no indication of the complete dominance of either yellow or black as far as coloration of abdomens and scutella of the worker progeny is concerned.

What has been tentatively designated as a haplo-diploid mosaic drone was discovered in the experimental apiary at Beltsville, Md. It bears dark hairs on one side of its thorax and yellow hairs on the other, and shows some difference of coloration in the two sides of the anterior abdominal tergites.

Studies on two different commercial strains of the Italian bee reared in this country showed one to be approximately twice as good as the other in honey-storing ability, and also to be definitely superior in amount of brood reared and in drawing out foundation.

Spores of *Bacillus larvae* failed to grow in culture after they were boiled in water for 6 hours and also after they were autoclaved at 15 pounds' pressure for 30 minutes. With all shorter periods of heating, growth was obtained in some of the cultures. Three hours of exposure to flowing steam failed to destroy all the spores. In concentrations ranging from 1 pound in 5 gallons to 1 pound in 30 gallons of water, both potassium hydroxide and sodium hydroxide failed to destroy spores of *B. larvae* within 3 days.

European foulbrood did not recur in colonies of Caucasian or Carniolan bees but did recur in all experimental colonies of common black bees.

INVESTIGATIONS OF INSECTS AFFECTING MAN AND ANIMALS

SCREWWORMS AND OTHER BLOWFLIES

Further research on the biology and habits of screwworms and other blowflies has developed promising methods of determining the influence of climatological and other ecological factors which favor the development of, and are responsible for, local outbreaks and the natural dissemination of these pests.

In the overwintering area in Texas, during 1937, foci in which factors appeared favorable for the rapid building up of screwworm fly abundance were located at certain points along the Rio Grande and in the lower Rio Grande Valley. By following the natural migration of the fly from the overwintering area and studying the rate at which the flies increased after reaching given localities, it was determined that all of Texas, parts of western Louisiana, and the lower desert section of Arizona were reinfested early in July. In 1937 the rate of migration was about the same northward as in 1936 but was more rapid toward the east. After spreading over the Gulf Coastal Plain in Texas the screwworm population reached its peak early in May. Along the escarpment of the Edwards Plateau the build-up of the fly population was at a more rapid rate and did not reach its peak until early in June. On the Edwards Plateau the flies were continuing to increase at the end of July. With the

exception of a narrow strip along the lower Gulf coast, the maximum fly abundance on the Gulf Coastal Plain was never more than 50 percent of that in the area along the escarpment.

Cochliomyia americana C. and P., the primary screwworm fly, overwintered in Texas south of the Edwards Plateau escarpment and as far eastward as San Antonio. Overwintering also occurred under experimental conditions at Valdosta, Ga., and Gainesville, Fla. Results of hibernation studies indicate that the fly is unable to survive the winter in Arizona or at Menard or Dallas, Tex. These studies also showed during the winter of 1936–37 a possible maximum "carry-over" period, that is, from the egg to the death of the last fly in the same generation, of approximately 3 months at Uvalde, Tex., and somewhat longer at Gainesville, Fla., and Valdosta, Ga.

Other investigations on the biology and habits of the screwworm indicate that in certain areas the percentage of infestation in wild animals is as high as or higher than in livestock; that the greatest increase in numbers of this species of fly is in areas having a high wild-fauna population; and that in areas where control measures are efficiently carried out for livestock the fly population is maintained by the breeding of the parasites in wild animals.

Studies on the effect of acidity and moisture content of the soil on the emergence of *Cochliomyia americana* have shown that grown larvae are able to withstand greater extremes of acidity and alkalinity than exist naturally in the soil. Nearly 50-percent emergence was obtained in sand one-fourth saturated with 0.2N sulphuric acid, and also in sand one-fourth saturated with 1.0N potassium hydroxide. Decreasing tolerance for acid or alkali media occurred with increasing saturation.

A distinct forward step in the control of screwworm flies has been indicated by the results obtained in experiments with phenothiazine as a larvicide. This material when applied to a wound prevents the establishment of newly hatched larvae in the tissues of the host but does not repel flies from the wound or prevent oviposition. Thus injury to the animal by the parasite is prevented and at the same time the breeding of the flies is greatly reduced. Considerable attention has been given to the testing of numerous other organic and inorganic substances producing the same effect as phenothiazine, and some of these are distinctly promising and warrant further investigation.

Other experiments for the development of larvicides and repellents for blowflies have shown that a mixture of 73.5 percent of a pine oil, 1.5 percent of 95-percent nicotine, and 25 percent of a wetting agent gave satisfactory control of all stages of the larvae of *Cochliomyia americana* in wounds. Benzol made miscible with water by the addition of 10 to 25 percent of a wetting agent was much more effective in killing screwworm larvae in wounds than was benzol alone, when no cotton packing was used in the wound.

Preliminary tests were made of the following larvicide-repellent combinations: (1) A pine oil 73.5 percent, nicotine (95 percent) 1.5 percent, and a wetting agent 25 percent; and (2) benzol 55 percent, diphenylene oxide 20 percent, and a wetting agent 25 percent. The tests indicated that as compared with benzol, when the latter is used with cotton packing and followed by applications of pine-tar oil, they are superior in killing the larvae, reducing the number and severity of infestations, and reducing the healing period of wounds.

Experiments to determine the fraction or fractions of pine-tar oil responsible for its fly-repellent property and its injurious effect on the skin of animals have shown that a certain fraction of pine-tar oil appears to be more repellent to blowflies than pine-tar oil. This material, however, causes more severe injury to the tissues of animals. Other fractions of pine-tar oil tested showed no value as fly repellents. Fraction 1 of retene oil was about as repellent as pine-tar oil but was more injurious than the latter when applied to the normal skin of animals.

Attempts to infect *Cochliomyia americana* experimentally with a species of *Empusa*, a parasitic fungus fatal to *C. macellaria* and *Phormia* spp., were unsuccessful.

Sodium cyanide (one-fourth ounce per gallon of water) and carbon disulphide (one-eighth pint of a 1:1 emulsion with neutral Turkey Red oil to 1 gallon of water) were both 100 percent effective in destroying the larvae of *Cochliomyia americana* and other blowflies in the soil when applied at the rate of 2 gallons per square yard of soil surface. The former solution was also effective in killing pupae of *C. americana* in the soil.

Studies on the life history and habits of the Gulf coast tick, one of the most serious predisposing causes of screwworm attack in the Southeast, have indicated practical methods of controlling this species of tick.

To study the screwworm problem and develop practical control measures under range conditions the Bureau has established a ranch experiment station at Menard, Tex., comprising some 1,200 acres and using approximately 900 sheep, goats, and cattle as experimental animals.

CATTLE GRUBS

Experiments with solutions of rotenone have yielded a simple and efficient method for reducing the abundance of cattle grubs. A solution composed of 50 cc of benzol, 5 cc of cresol, 45 cc of liquid petrolatum, and 1 g of rotenone was found to be as efficient when applied to the surface of the skin and rubbed with the fingers as when the solution was injected into the opening of the lesions individually. The survival of grubs from such general applications ranged from 1.25 to 7.69 percent. When this method is used, from three to five times as many cattle can be treated by one operator as when the solution is injected into the lesions individually. The method is particularly suited to the treatment of dairy cattle and provides a cheap, quick remedy against the losses to the dairy industry occasioned by these pests.

A histological study of the migrations of the larvae in the host have corroborated earlier findings resulting from gross examination. The investigations also showed that the esophagi invaded by the cattle grub exhibited an extensive inflammatory edema, which was confined mainly to the outer layers and was composed principally of a hematogenous exudate, with eosinophils, plasmocytes, and lymphocytes predominating. Infiltrating fluids caused distortion and injury resulting in an apparent weakening of the walls of the esophagus.

CATTLE AND HORSE LICE

In experiments on the control of lice on cattle and horses where the use of a dipping vat is not feasible, as is often the case during the winter months, the powdered roots of derris and devil's shoestring have been found efficient and economical because of their effectiveness even when greatly diluted. Derris root containing 3 percent of rotenone was effective for both biting and sucking lice when diluted to 0.125 percent rotenone by mixture with diatomaceous earth in the ratio of 1 part to 23 parts of the diluent by weight. Powdered devil's shoestring diluted to the same concentration of rotenone was equally effective.

It was found also that a solution of 0.5 g of rotenone in 100 cc of carbon tetrachloride, when sprayed lightly into the coat of an animal with an ordinary hand sprayer, is a very prompt and effective treatment. The carbon tetrachloride evaporates almost instantly, leaving the fine particles of rotenone in the hair. While this preparation is more easily and more rapidly applied than the powders, the materials are more costly, since about 4 fluid ounces of the solution was required to treat a full-grown animal.

GOAT LICE

Following the experimental work of the Bureau which demonstrated the effectiveness of 325-mesh wettable sulphur for the control of lice of sheep and goats, many ranchmen in certain parts of the Southwest are enthusiastically employing this material for ridding their flocks of these parasites. The treatment is reported to increase the mohair production approximately one-fourth pound per animal. In order to make the sulphur usable as a dip with all kinds of water, over 400 tests have been made to determine the best wetting agent to be used in connection with the sulphur in alkaline waters. These tests have determined that at least six combinations of neutral sodium oleate with sulphonated-alkylated diphenyl, a sulphonic acid of an aromatic hydrocarbon, and a sodium salt of alkyl ester of sulphosuccinic acid are suitable as wetting agents in water rendered alkaline by the presence of sodium or magnesium salts.

FLY SPRAYS AND REPELLENTS

In investigations in the development of more efficient fly sprays and repellents, especially for use on livestock and in barns, a biological method of assaying the insecticidal value of fly sprays has been perfected in which use is made of an accurately regulated mechanism governing the air stream, dosage,

etc. The insects are sprayed in a regulated air stream and allowed to recover in a ventilated cabinet. Initial effect and rate of recovery from median lethal doses are used as criteria of toxicity.

An insect olfactometer has been designed and built that will aid in determining the relative attraction or repellence of chemicals, and various odoriferous substances can be rather accurately measured.

In these studies a moderately satisfactory method of producing large numbers of stableflies was developed. Adults are fed acidulated beef blood, and the larvae are reared on a medium of a moist mixture of crimped oats and rotten straw.

SHEEP TICK

Studies on the biology and habits of *Melophagus ovinus L.*, an important northern parasite of sheep, indicate that during the last 15 to 20 years a strain of the insects has developed which will withstand the hot, dry weather of the Southwest and that it is rapidly becoming a serious problem upon the ranges of that section of the country. Preliminary tests on the control of this pest have shown that 325-mesh wettable sulphur used as a dip is effective in destroying all the adults infesting an animal, but that it is not effective in killing pupae.

TICKS AFFECTING MAN AND ANIMALS

Tests to determine the efficacy of methods usually employed in killing the American dog tick and the winter tick show that the fully engorged females of these two species are very resistant to the chemicals usually employed to kill ticks. It was found, however, that derris powder containing from 1 to 3 percent of rotenone was effective in killing all but the engorged females of the American dog tick and that derris powder and devil's shoestring containing approximately the same amount of rotenone was satisfactory in ridding horses and cattle of the winter tick. From 4 to 9 ounces of derris powder or devil's shoestring was required to treat an adult horse or cow.

Because of the increasing importance of Rocky Mountain spotted fever in the East, investigations are under way to determine methods of destroying the tick vector (*Dermacentor variabilis*) over relatively large areas. These studies are concerned principally with the destruction of the ticks on wild and domestic animal hosts and the use of insects parasitic on the ticks.

In order to place work on the eradication of the southern cattle tick (*Boöphilus annulatus australis* Fuller) in Puerto Rico on a sound basis a study of the host relations, habits, and life history of this tick was begun in cooperation with the Puerto Rico Reconstruction Administration and the Bureau of Animal Industry of the United States Department of Agriculture.

HOUSEHOLD AND STORED-PRODUCT INSECTS

Considerable work was done in assembling and publishing information on the control of cockroaches, bedbugs, ants, clothes moths, carpet beetles, fleas, and other household insects to meet the needs of the Bureau in answering thousands of requests from individuals, exterminating companies, and commercial concerns for methods of combating these pests.

Cooperation has been extended the custodians of the various Federal buildings and to quartermasters charged with protecting furnishings, fabrics, and foodstuffs subject to insect atttack.

Inspections were made of certain brush-manufacturing plants and wholesale houses in Maryland, Virginia, North Carolina, South Carolina, Georgia, and Alabama for infestations of the furniture carpet beetle (*Anthranus vorax* Csy.) to determine the extent of spread of this recently introduced and serious pest. Advice on methods of control was given to the companies concerned. The brush factory of the Federal Bureau of Prisons at Fort Leavenworth, Kans., which was heavily infested with this beetle, was fumigated under the technical direction of a representative of the Bureau.

A large number of tests, chiefly in cooperation with the Army and Navy quartermasters and the Federal Trade Commission, have been made to determine the effectiveness of various moth-proofing solutions for protecting fabrics against damage by moth and carpet beetle larvae. The results reveal a distinct improvement in the solutions now employed by commercial concerns over those

formerly used, but there is no indication that a moth-proofing agent has yet been developed which imparts a permanent insect-resistant quality to the fabrics.

Observations on the larder beetle indicate that the insect has only one generation a year in northern Vermont, whereas at Washington, D. C., several generations may be produced. The effectiveness of hydrocyanic acid gas in destroying this pest in large warehouses and in carload shipments of liver meal and other animal products to be used as fertilizers was demonstrated.

MOSQUITOES

Recent experiments have shown that paris green, when mixed with water and applied as a spray, is very effective for destroying the subsurface-feeding larvae of culicine mosquitoes. In a number of field tests with this arsenical, carried out under various conditions, high percentages of larval control have been obtained with several important economic species, including the salt-marsh mosquito *Aedes taeniorhynchus* Wied., the fresh-water species *Psorophora columbiae* D. and K., and the southern house mosquito. Treatments were effective when the arsenical was applied with a sprinkling can or knapsack sprayer at rates as low as 1 pound per acre. Two preliminary tests were made with an autogiro as a means of applying the spray, and the results indicated that this type of airplane, with its comparatively low speed, could probably be adapted for treating large breeding areas that are not otherwise accessible.

Samples of calcium arsenite having a comparatively high percentage of water-soluble arsenic were found to be nearly as toxic for mosquito larvae as paris green. This product may therefore prove to be a satisfactory substitute for use in both anopheline and culicine mosquito control. While this form of arsenical is apparently not yet available commercially, it seems probable that such a product can be produced at a cost appreciably lower than that of paris green.

An acetone solution of phenothiazine was known to be much more toxic for mosquito larvae than the undissolved material. Recently it has been found that the addition of a sulphonated petroleum oil reduces greatly the amount of acetone solvent required, while providing a combination that is readily miscible with water. In preliminary laboratory experiments this solution gave 100-percent mortality in tests with larvae of *Culex quinquefasciatus* at a phenothiazine dilution as high as 1 to 2,000,000.

A study was made of the distribution of the important tropical malaria mosquito *Anopheles albimanus* Wied., with special reference to the possibility of its introduction into the Southeastern States. At present this species occurs in the United States only in the lower Rio Grande Valley of Texas, and, judging by the apparent temperature limitations there, it seems unlikely that it could survive in other portions of the Gulf Coast States except in southern Florida, where climatic conditions would appear to be favorable for its propagation if once introduced and allowed to become established.

Studies on the biology and habits of the two floodwater mosquitoes *Aedes aldrichi* D. and K. and *A. vexans* Meig. in the Pacific Northwest, particularly along the lower Columbia River, have shown that both species and both sexes were dispersed in all directions, both with and against general wind currents, for a distance of from 2 to 5 miles from the breeding ground, and that there was a gradual dispersal up the tributaries of the Columbia River for distances of 8 and 10 miles. The extreme longevity of these species was 112 days for females and 94 days for males. In years of low floods of the Columbia River—that is, about 10.5 feet—73.4 percent of the mosquito population is *Aedes vexans* and 26.6 percent *A. aldrichi*. In years of average high floods—about 19.7 feet—only 13.8 percent of the population is *A. vexans* and 86.2 percent *A. aldrichi*. Studies of the factors influencing the hatching of eggs of these two species show that in the dormant stage they quickly lose their viability upon exposure to relatively long periods of inundation; that under normal conditions they may remain viable for at least 3 years in nature; and that overwintering eggs will not hatch when moistened with river or tap water but will respond quickly when treated with various infusions, phosphates, asparagine, and a number of other amino acids. These data have an important bearing on the type of mosquito-control methods to be used and should be taken into consideration in connection with any control work in areas where *Aedes vexans* and *A. aldrichi* are serious pests.

In cooperation with the Bureau of Biological Survey, the Civilian Conservation Corps, and the State agencies concerned in mosquito control in Maryland, New Jersey, and Delaware, work was begun to assist the C. C. C. camps to carry out more effectively the mosquito-control projects to which they were assigned in these States.

Surveys were made to determine the more important mosquito-breeding areas. Advice was also given as to the most practical procedure to be followed in abating the mosquito plague in different areas. Intensive surveys of the fauna and flora of the marshes are being made to determine the relationship between mosquito-control operations and the disturbance of wildlife on tidal marshes, and to weigh the probable influence of different types of control on these forms of life. These surveys are not yet complete but present data indicate that with a knowledge of the soil types, water levels, and other factors, the time and expense of ditching marshland may be kept at a minimum, the mosquito control made more effective, and wildlife disturbed but little. If there is no great change in the salinity of the water passing into them, marshes which have a compact soil, are flooded by lunar tides, and have a fairly good tide range in the ditches will maintain their original vegetation in good condition. On the other hand, marshes which have a porous soil on which water has been practically impounded over long periods will show marked changes if the surface water is removed and the water table permanently lowered.

SAND FLIES

For relief from the annoyance of sand flies in houses it has been found that a mixture of 1 part of commercial pyrethrum extract and 20 parts of very light lubricating oil applied to the window and door screens gives good protection for a considerable length of time to persons inside the houses.

SURGICAL MAGGOTS

Following the discovery of the value of urea as a healing agent, considerable work of a service nature has been performed by the Bureau in supplying information to both doctors and laity as to where urea could be purchased and the methods of its application. Much work of the same nature is still required on the subject of allantoin, another compound found in maggot secretions.

The search for healing agents present in maggot excretions was continued during the year. Two substances, ammonium carbonate and ammonium bicarbonate, which occur in the excretions were given preliminary tests, but in general the results obtained with them did not appear to be distinctly beneficial, and the experiments were discontinued.

In studies of the anatomy and physiology of blowfly maggots to determine how these organisms produce their healing or beneficial effects, considerable improvement has been made in research technique. A vital dye, alizarin, has been used with much success in determining the hydrogen-ion concentration of various parts of the alimentary canal. It is given with the food of the larvae, and when eaten it stains various parts of the digestive tract a characteristic red or yellow. This same dye is being used to determine calcium metabolism of the fly maggots.

FIRE ANTS

Numerous tests of methods to control fire ants (*Solenopsis* spp.), which are so destructive to young quail and otherwise injurious in the Southeastern States, have shown that approximately 50 percent of the fire ant colonies can be destroyed by applying a solution of sodium cyanide containing 1 ounce of the chemical to a gallon of water. Applications of more than 1 ounce of sodium cyanide per gallon of water increase the efficiency of the method in sandy soils, but 1 ounce of the dry cyanide placed 3 to 6 inches deep appears to be more efficient than the liquid material on clay soils, although less efficient on sandy soils. Better kills are obtained if the liquid cyanide solution is poured down the galleries rather than into holes punched into the ground around the colony. Greater kills may be expected if the colonies are treated as early as March and April rather than in May, June, or July, and a greater percentage of the colonies were destroyed when the materials were applied in wet weather than under dry conditions.

Tests with carbon disulphide, both as a liquid and as an emulsion, and chloropicrin indicated that they were satisfactory materials for destroying the colonies.

SCREWWORM CONTROL

The cooperative campaign for control of screwworms was similar to that of last year, except that some of the educational phases were of a more advanced nature, demonstrations on fundamental livestock practices for prevention of screwworm attacks were carried on by cooperating stockmen, and most of the supervisors were assigned to larger territories. By employing 155 field men for varying periods the program was effectively extended to practically all infested areas of the Southern States.

The work for the year again made use of the State and Federal agencies interested in livestock. The State screwworm control committee in each State cooperated and assisted in effective work with county agricultural agents, veterinarians, teachers of vocational agriculture, and individual stockmen and farmers. The procedures were directed from field headquarters at San Antonio, Tex., and supervisors were supplied with posters, circulars, handbills, timely articles for the press, radio talks, exhibits, and supplies. In each State the supervisors received special instructions on the life cycle, methods of detecting and preventing cases, proper methods of treating cases with benzol and pine-tar oil, and the principal variations in the causes of screwworm abundance in different areas. At these conferences the good preventive measures endorsed by State agencies usually included (1) controlled breeding to reduce cases in navels and in mothers of young; (2) dehorning of young animals during cool weather and horn tipping of older animals to reduce infestations caused by horn hooks; (3) use of bloodless emasculators on cattle, sheep, and goats in order to avoid cases which usually follow the use of the knife; (4) control of the Gulf coast and spinose ear ticks; (5) elimination of the use of catch dogs; (6) avoiding rough handling of livestock so as to reduce snags and scratches; and (7) the use of dehydrated pine-tar oil on all open wounds to aid healing and to prevent flies from laying eggs on wounds.

During the year 7,608 demonstrations of recommended practices of handling and managing livestock for prevention or treatment of injuries of animals were made by good stockmen. These demonstrations were conducted by owners of farms and ranches as examples for different communities, and limited quantities of treating materials were furnished them. Small quantities of materials for treating carry-over infestations of the winter were also furnished to stock owners who cooperated in combating screwworms when the incidence of cases was at a low point. Altogether, 5,398 gallons of benzol and 7,262 gallons of pine-tar oil were used for such purposes.

CONTROL WORK IN THE SOUTHEASTERN STATES

Activity of screwworms during the winter is restricted to areas in which the mean winter temperature is above 55° F. This natural control does not become effective early enough in the fall to aid in preventing destructive outbreaks when animals are marked, castrated, and fattened in the fields of the Southeastern States. The high control of the pest obtained during the fall of 1936 was due to good cooperation by stock owners throughout the year. Such continuous work resulted in confining the pest principally to the southern counties of Georgia and to the peninsular portion of Florida, where there was some activity during the winter months. The additional work carried on in these areas during the winter (1) reduced the stock of parent flies in the spring; (2) served in keeping screwworms in check so that a big population did not breed up in navels of young animals; (3) greatly reduced the infestations from surgical operations; and (4) retarded spread of the pest.

The following are the average rates of infestation among 100,000 animals in Florida: In 1935, July 3,447, August 3,613, September 2,802, October 2,049, November 2,148, December 1,105; in 1936, January 374, February 257, March 236, April 687, May 863, June 797, July 581, August 489, September 653, October 833, November 454, December 93; and in 1937, January 240, February 284, March 214, April 345, May 694, June 940, and July 867.

The retardation of spread by control work was strikingly illustrated by the first occurrence of cases of screwworms at Hinesville, Ga., during the last 2 years. In 1936 the first cases occurred on May 1, and in 1937 the first case did not occur until May 25. This difference in the early occurrence of cases is attributed only to control work which delayed spread of the pest and enabled southern Georgia to escape a generation of screwworms. The delay of spread

was accomplished in spite of the fact that high temperatures, beginning in Florida as early as the last week of December, greatly favored an early build-up of screwworms for the year.

In South Carolina reports were received of 73 cases, and in 6 instances, representing 5 counties, primary screwworms were definitely identified. In each instance the pest was promptly stamped out by the efforts of local stockmen. In Georgia the pest was prevented from spreading from the open-range area to farming sections, and was not permitted to invade animals that were fattened in bean and peanut fields in the fall. In Alabama screwworms were identified from two widely separated counties, Barbour and Sumter, but both infestations were promptly stamped out by diligent efforts of stock owners. In Louisiana cases occurred at stockyards and horse-trading centers late in the fall or early in the winter. Prompt treatment of such cases by employees of the yards apparently stamped out these imported infestations.

The cumulative results of screwworm control work in the Southeast are reflected in the reported or estimated cases and in the death rates during the last few years. In 1923 there were approximately 75,000 cases of screwworms in Georgia, and animals in about 20 counties in northern Florida became infested. By the end of 1934 it was estimated that 1,300,000 cases had occurred in the Southeastern States, and an educational and demonstrational program was considered a necessity. In 1935, when control work was carried on, only 228,660 cases were reported by local supervisors, and in 1936 there was a further reduction to 48,737 reported cases. A summary of the educational campaign of the year 1937 is given in table 17. During 1934 it was estimated that approximately 12 percent of the infested animals in the Southeast died of screwworm infestation. In 1935 there were 2,520 deaths among 100,000 infested animals. In 1936 only 322 deaths were reported among 45,829 infestations in Florida, or at the rate of 702 deaths among 100,000 infested animals. The reported cases in the Southern States are summarized by weeks for the year 1937 in table 18.

TABLE 17.—*Summary of educational work on screwworm control, fiscal year 1937*

State	Meetings and demonstrations held	Attendance at meetings and demonstrations	Stockmen visited on farms and ranches	Exhibits	Attendance at exhibits	Circulars and bulletins distributed	Posters and handbills distributed	Newspaper articles published	Radio talks given	Practices demonstrated by stock owners
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Alabama	114	4,266	5,498	9	12,482	4,316	171	36	0	1
Arizona	149	1,465	4,676	19	32,275	1,494	81	19	0	159
California	288	7,891	5,678	33	110,516	9,938	169	52	0	73
Florida	2,685	24,437	81,326	38	295,391	27,813	51,536	622	5	4,383
Georgia	1,741	28,531	43,395	19	65,470	37,810	1,332	404	6	2
Louisiana	7	96	1,831	4	536	1,254	2,330	22	0	23
Mississippi	33	1,355	2,585	7	28,500	5,921	651	20	0	36
New Mexico	239	7,841	7,504	28	162,785	8,137	388	39	3	943
Oklahoma	238	12,251	4,003	153	67,904	7,404	350	25	8	68
South Carolina	94	2,681	2,381	8	33,010	2,937	797	34	0	12
Texas	1,984	39,380	59,439	845	499,625	66,028	3,318	912	5	1,908
Total	7,572	130,194	218,316	1,163	1,308,494	173,052	61,123	2,185	27	7,608

TABLE 18.—*Reported cases of screwworms and maggots in the Southern States, fiscal year 1937, by weeks*

Week ended—	Alabama	Arizona	California	Florida	Georgia	Louisiana	Mississippi	New Mexico	Oklahoma	Texas	South Carolina	Total
1936	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
July 3	33	------	10	1,107	13	3	2	------	0	4,656	1	5,825
July 10	24	------	0	828	21	1	3	1	9	4,490	5	5,382
July 17	9	8	0	839	15	16	4	1	17	7,105	7	8,021
July 24	29	9	0	834	18	6	4	396	23	14,650	3	15,972
July 31	20	49	0	772	4	9	0	469	71	7,647	15	9,056
Aug. 7	18	34	2	725	21	12	2	5,367	21	6,740	9	12,951
Aug. 14	6	44	1	834	24	3	3	894	15	8,443	1	10,268
Aug. 21	8	71	21	916	22	8	2	1,279	134	6,273	5	8,739
Aug. 28	4	69	28	885	44	3	5	1,505	109	6,041	3	8,696
Sept. 4	9	170	24	1,204	37	15	0	691	74	3,785	2	6,011
Sept. 11	10	81	0	776	42	25	1	1,241	107	3,559	1	5,843
Sept. 18	3	66	64	1,195	46	9	1	3,293	85	3,205	5	7,972
Sept. 25	0	48	64	1,303	47	9	0	1,102	4	4,980	7	7,564
Oct. 2	0	82	12	1,643	101	0	1	217	52	4,904	0	7,012
Oct. 9	0	39	21	1,308	168	3	0	1,527	41	3,533	8	6,648
Oct. 16	0	118	101	1,306	182	2	1	940	26	3,903	1	6,580
Oct. 23	0	113	24	1,249	354	0	1	1,664	47	3,118	0	6,570
Oct. 30	0	2	164	845	333	5	108	408	15	1,512	0	3,392
Nov. 6	8	78	32	481	330	7	0	208	18	1,811	0	2,973
Nov. 13	0	69	20	1,157	164	3	14	66	73	1,272	0	2,838
Nov. 20	0	0	11	1,426	51	0	12	0	75	459	0	2,034
Nov. 27	0	8	446	753	6	0	16	0	0	367	0	1,596
Dec. 4	0	8	17	661	1	0	0	0	2	534	0	1,223
Dec. 11	0	56	124	419	0	0	6	0	7	347	0	959
Dec. 18	------	1	20	219	------	------	------	0	0	78	------	318
Dec. 25	------	24	0	170	0	0	------	0	0	34	------	228
Dec. 31	------	2	0	194	0	0	------	0	0	128	------	324
1937												
Jan. 8	------	0	0	427	0	0	------	0	0	411	------	838
Jan. 15	------	0	0	790	0	0	------	0	0	120	------	910
Jan. 22	------	0	0	979	1	0	------	0	0	116	------	1,096
Jan. 29	------	0	0	1,017	1	0	------	0	0	28	------	1,046
Feb. 5	------	0	0	1,052	2	0	------	0	0	14	------	1,068
Feb. 12	------	0	0	900	0	0	------	0	0	34	------	934
Feb. 19	------	0	0	851	0	0	------	0	0	45	------	896
Feb. 26	------	0	1	770	1	0	------	0	0	205	------	977
Mar. 5	------	0	0	722	0	0	------	0	0	326	------	1,048
Mar. 12	------	0	0	644	0	0	------	0	0	370	------	1,014
Mar. 19	------	2	0	627	0	0	------	0	0	395	------	1,024
Mar. 26	------	0	0	937	0	------	------	0	0	469	------	1,406
Apr. 2	------	27	0	870	0	------	------	0	0	252	------	1,149
Apr. 9	------	8	0	1,155	0	------	------	0	0	417	------	1,580
Apr. 16	------	84	11	986	0	------	------	0	0	480	------	1,561
Apr. 23	------	0	5	1,299	0	------	------	0	0	790	------	2,094
Apr. 30	------	9	0	1,076	0	------	------	0	0	1,726	------	2,811
May 7	------	32	0	267	0	------	------	0	0	2,005	------	2,304
May 14	------	4	------	496	5	------	------	0	0	1,913	------	2,418
May 21	------	30	------	736	55	------	------	13	------	1,780	------	2,614
May 28	------	19	------	1,156	53	------	------	45	------	2,133	------	3,406
June 4	------	47	------	970	25	------	------	123	------	1,950	------	3,115
June 11	------	3	------	1,014	41	------	------	542	------	2,282	------	3,882
June 18	------	13	------	1,079	15	------	------	299	------	1,707	------	3,113
June 25	------	33	------	960	86	------	------	415	------	1,592	------	3,086
Total July 3, 1936, to June 25, 1937	181	1,560	1,223	45,829	2,329	139	186	22,706	1,025	125,134	73	200,385

CONTROL WORK IN THE SOUTHWESTERN STATES

The program was extended to the Southwestern States during June 1936, after the spring shearing of sheep and goats was completed. At that time screwworms were distributed over the western half of Texas and in the southern portions of other Southwestern States. In Texas the control work from June to December, inclusive, served gradually to reduce the rate of occurrence of infestations, which are shown as follows for the different months as averages among 100,000 animals; June 1,256, July 1,316, August 872, September 639, October 687, November 401, and December 195. This gradual reduction was in strong contrast to the outbreak of 1935, when an estimated 3,245,297 cases caused

a loss of about $10,000,000 in Texas. It is believed that normally the annual infestation in Texas is about 1,000,000 cases, and that the weather during 1936 was somewhat more favorable for screwworms than during a normal year. There were no extensive droughts and there seemed to be sufficient rainfall to keep wounds soft and attractive for screwworm flies, but not enough to result in drowning of immature stages in the soil. The cases in 1936 occurred at the average rate of 827 among 100,000 animals, and were estimated at 573,396 on the basis of 125,134 reported infestations. It seems conservative to attribute the difference between this estimate and that of a normal infestation to results of screwworm control work. In addition to a reduction in the number of cases, there was also a reduction in the mortality among infested animals. During 1935 the death rate was estimated at 14,732 among 100,000 animals, and in 1936 the mortalities were at an average rate of 9,410 among 100,000 infested animals. They are still high enough to emphasize the need for adopting better methods of treating animals, and especially is this true for cases occurring in sheep and goats.

In other Southwestern States control work started during June and some educational phases were continued through the winter months. From June to December, inclusive, the following were the average rates of infestations among 100,000 animals: Arizona 262, California 75, New Mexico 161, and Oklahoma 212. The infestations in all of these States were at the rate of only a fraction of 1 percent of the animal population. There was a wide variation in the mortality rates because in areas having a low incidence of cases there is a more fixed tendency of stockmen to use undiluted stock dips or other irritating materials for killing screwworms in wounds. The average rates of animals dying among 100,000 infested animals were as follows: Arizona 2,722, California 1,076, New Mexico 3,107, and Oklahoma none.

During the period when there was a good degree of control of screwworms in Texas and other Southwestern States, the pest was able to spread and cause at least 1,025 cases in Oklahoma, about 50 in Kansas, 25 in Missouri, about 100 in Illinois, and approximately 1,000 in southwestern Tennessee. These figures represent cases occurring during a dry year, in many of these areas, and a reduction from reports of the previous year, when there were about 30,000 cases in Kansas, 1,000 in Iowa, and 6,000 in Illinois. During 1936 workers in stockyards at different places examined animals and sent in specimens for identification. The following collections of primary screwworms were made: At Kansas City, Mo., 10; at East St. Louis, Ill., 39; at Kaplan and Church Point, La., 3; at New Orleans, La., 10 (of 59 cases); and at Nashville, Tenn., 1. These records show that there is an annual danger of introducing screwworms into uninfested States.

PREVENTION AND SHEARING

In the sheep- and goat-breeding area of southwestern Texas screwworms are normally present when the spring shearing begins, and they are able to spread rapidly across the area during the period required for shearing operations. In the spring of 1937 supervisors were assigned to several counties so that they could work among owners of sheep, advising them of the importance of treating shear cuts. The owners were visited in advance of shearing, and screwworm control workers urged that all shear cuts be treated with pine-tar oil to prevent infestation, and that animals having severe injuries be kept in holding pastures and treated until healed. This procedure did not prevent spread of the screwworms across the sheep- and goat-breeding area but it was most helpful in maintaining a low screwworm population. From June 20 to December 31, 1936, the average infestation in the sheep- and goat-breeding area was at the rate of 882 cases among 100,000 animals. Following special work in this area the average infestation in Texas for June 1937 was only 341 cases among 100,000 animals. Injuries of sheep, such as sore mouth, pinkeye, boils, prickly-pear injuries, and those caused by rams' fighting, are not easily avoided, but many animals escaped infestation because screwworms were at a low level. In the southeastern counties of New Mexico the treatment of shear cuts reduced screwworm infestations, but in Quay County, where no special work was done, an infestation of about 2 percent of the animal population developed in the latter part of June.

SUMMARY

The screwworm control work of the year resulted in (1) reducing infestations and death losses among livestock in Texas and other Southwestern States and further reducing cases and mortalities in the Southeastern States; (2) effectively preventing the building up of large numbers of screwworms in different

southern areas; (3) detecting the presence of screwworms in advance of the gradual spread of the pest in the Southeastern States; (4) enlisting the efforts of stockmen in stamping out localized infestations in advance of the regular spread of the pest in the Southeastern States and in stockyards; (5) effectively reducing cases in the overwintering areas so as to reduce the number of parent flies in the spring and to retard development of large populations of screwworms; and (6) preventing a build-up of screwworms in shear cuts in the sheep- and goat-breeding area of Texas and in southeastern New Mexico.

INSECT IDENTIFICATION

During the year 48,999 different lots of material were received for identification, and the number of determinations made totaled 77,856, an increase of more than 20,000 over the number reported for 1936. Sixty-eight percent of the identifications were for interceptions by the Division of Foreign Plant Quarantines, 16 percent related to material submitted by the remaining divisions of the Bureau and other Federal agencies, and the balance applied to specimens received from State experiment stations, agricultural colleges, and other institutions in the United States and its territorial possessions and from numerous individuals, both in this country and abroad. At the end of the year 6,277 lots remained unfinished, this number being slightly higher than the corresponding figure for 1936. Assistance has also been given to numerous taxonomic specialists, both American and foreign, attached to educational institutions, museums, and experiment stations, in connection with the solution of problems in insect classification.

During the brief periods not required for identification work, investigations were conducted on a variety of taxonomic problems with the object of improving the classification of difficult economic groups that have been in a state of confusion. Forty-three manuscripts were completed and submitted for publication, 24 of which were published. Most of these papers are very short, but a few that are comprehensive treatments of larger groups present the results of studies that have been under way for several years and include, for example, a revision of the horseflies of the subfamily Tabaninae and one covering the mites belonging to the subfamily Tarsoneminae.

Studies, unavoidably intermittent because of the demands for identifications, have been begun on the classification of various economic groups. Following are some of the larger of these undertakings: Classification of the white grubs; revision of the wood-boring beetles of the genus *Chrysobothris;* revision of the blowflies; revision of the fruitflies of the genus *Anastrepha;* revision of the moths of the family Gelechiidae; monograph of the moths of the family Tortricidae; revision of the moths of the family Oecophoridae; classification of the New World moths belonging to the Phycitinae; generic classification of the fleas; revision of the bee genus *Osmia;* studies on the classification of chiggers; revision of the parasitic wasps of the genus *Ophion;* generic classification of the leafhoppers of the family Cicadellidae; revision of the aphids belonging to the genus *Myzus;* studies on scale insects of the genus *Asterolecanium;* and a morphological study of the male genitalia of the Hymenoptera.

FOREIGN PARASITE INTRODUCTION

Particular attention was given to the collection and importation of natural enemies of the oriental fruit moth, the pine shoot moth (*Rhyacionia buoliana* Schiff.), the larch casebearer, the hessian fly, the European corn borer, the pea weevil, the vetch bruchid, and the lima bean pod borer. The importations of fruitfly parasites into Hawaii and of parasites to be used against a variety of pests in Puerto Rico, both under special funds, have been completed.

PARASITES OF FRUIT INSECTS

Shipments of cocoons and adults of oriental fruit moth parasites from Japan and Chosen during the fall of 1936 totaled 19,335, representing 16 species. These are the same as have been imported in preceding years. During the spring of 1937 a total of 102,166 infested peach twigs were collected in Japan and 121,085 in Chosen, and the parasites contained in them, numbering 41,439, were forwarded during June.

PARASITES OF FOREST INSECTS

The field of investigation of pine shoot moth parasites was shifted from England to the Netherlands for the collection of material during May and June 1937. A total of 3,440 cocoons, comprising 8 or more species, were forwarded, and also 6,500 dead host larvae containing an estimated 100,000 *Copidosoma geniculatum* Dal.

A total of 7,100 parasites of 8 species emerged from the 102,000 larch casebearer larvae shipped from England in 1936. The collections in 1937 were made in the Netherlands and 53,500 host cases were shipped during May.

PARASITES OF CEREAL AND FORAGE INSECTS

Attention has been given to securing two European parasites of the hessian fly for colonization in the United States. These, however, have not proved to be abundant in any section. Large quantities of infested wheat straw were set aside for parasite emergence, and 1,090 *Platygaster pleuron* Walk. and 855 *Trichasis remulus* Walk. were reared out and shipped.

Investigations of parasites of the European corn borer were limited to Italy, where collections for *Chelonus annulipes* Wesm. were made. A total of 85,000 host larvae were shipped late in 1936, and these were estimated to contain 5,500 *Chelonus* and probably a larger number of other parasites.

PARASITES OF TRUCK CROP AND GARDEN INSECTS

Extensive shipments of pea weevil parasites were made during the summer of 1936 from France and Austria. A total of 5,600 *Triaspis thoracicus* Curt. were obtained from 400 pounds of infested horsebeans shipped from France and reared out under quarantine conditions. In addition 30,000 adults of the same species were shipped from Austria. The number that reached the Pacific Northwest alive and were colonized totaled 26,500. The spring shipments of 1937 contained approximately 65,000 parasites of the same species. A portion of these are to be utilized against the vetch bruchid in the Eastern States.

Preliminary studies were made upon the parasites of the lima bean pod borer in France and Austria, and it was determined that several promising parasites occur in those countries. Small test shipments of *Microbracon piger* Wesm. and *Phanerotoma planifrons* Nees were made during the summer of 1936.

IMPORTATION OF FRUITFLY PARASITES INTO HAWAII

The exploratory work under this special project was completed late in the summer of 1936. During the 6-month period covering actual importations 2,556 adult parasites of 14 species and 68 predacious beetles of 2 species reached Hawaii alive. These originated in West Africa, Brazil, Puerto Rico, Mexico, Malaya, and India. No recoveries of these natural enemies have yet been made in Hawaii.

PARASITE IMPORTATIONS INTO PUERTO RICO

The work in Puerto Rico under special funds was completed in September 1936, since which time further activities in this line have been on a cooperative basis with the Office of Experiment Stations. The principal shipments of the year are listed in table 19.

TABLE 19.—*Shipments of parasites into Puerto Rico during the fiscal year 1937*[1]

Host	Parasite	Number shipped
Lima bean pod borer	*Macrocentrus ancylivorus* Roh	5,530
Pineapple mealybug	*Anagyrus coccidivorus* Doz	102
Do	*Hambletonia pseudococcina* Comp	88
Pink bollworm	*Exeristes roborator* F	10,300
Do	*Chelonus blackburni* Cam	19,200
West Indian fruitflies	8 species	2,600
White peach scale	*Prospaltella berlesei* How	863

[1] In addition a total of 7,500 dung beetles, of 4 species, were shipped from Texas and Hawaii.

Field recoveries of two additional species have been made during the year. The coccinellid beetles imported from Trinidad in January 1937 have apparently brought about complete control of the coconut scale in the sections where they have been colonized.

COOPERATION WITH FOREIGN ORGANIZATIONS

In cooperation with the Entomological Branch of the Canadian Department of Agriculture, and with funds provided by that department, the Bureau station at Yokohama, Japan, collected and forwarded 213,000 field-collected cocoons of *Diprion nipponica* Roh., the parasites from which will be utilized against the spruce sawfly. Arrangements were made for sending a colony of *Ephialtes examinator* F. to Canada for use against the pine shoot moth and of *Heterospilus cephi* Roh. for use against the wheat stem sawfly. The parasites and predators received from the Canadian Department of Agriculture during the year are listed in table 20.

TABLE 20.—*Parasites and predators received from Canada during the fiscal year 1937*

Host	Parasites	Number received
European corn borer	*Chelonus annulipes* Wesm	7,665
Fir bark louse (*Adelges piceae* Ratz.)	*Leucopis obscurus* Hal	569
Spruce sawfly	*Exenterus abruptorius* Thunb	2,890
Do	*Microplectron fuscipennis* Zett	500,000
Black grain-stem sawfly	*Collyria calcitrator* Grav	5,100

Through the cooperation of the different divisions of the Bureau, shipments of parasites and predators have been forwarded during the year to the countries listed in table 21.

TABLE 21.—*Shipments of parasites and predators to foreign countries during the fiscal year 1937*

Country	Host	Parasite
Argentina, Australia, Uruguay.	Oriental fruit moth	*Macrocentrus ancylivorus* Roh.
Do	do	*Glypta rufiscutellaris* Cress.
Argentina, Uruguay	do	*Bassus diversus* Mues.
Do	do	*Ascogaster quadridentata* Wesm.
Costa Rica	Woolly apple aphid	*Aphelinus mali* Hald.
Egypt	Pink bollworm	*Chelonus blackburni* Cam.
Do	Cotton worm (*Prodenia litura* F.)	*Bufo marinus* L.
Mauritius	Cane grubs (*Phytalis* spp.)	*Pyrophorus luminosus* Ill.
Mexico	Woolly apple aphid	*Aphelinus mali* Hald.
Peru	Codling moth	*Ascogaster quadridentata* Wesm.
Do	Mealybugs (*Pseudococcus* spp.)	*Cryptolaemus montrouzieri* Muls.
Do	Cane beetles (Scarabaeidae)	*Bufo marinus* L.
Santo Domingo	Coconut scale (*Aspidiotus destructor* Sign.)	*Pentilia castanea* Muls.
Do	do	*Cryptognatha nodiceps* Marshall.

CONTROL INVESTIGATIONS

TESTS OF ORGANIC COMPOUNDS AND PLANT PRODUCTS AS INSECTICIDES

In the testing of organic compounds as insecticides, 56 were found that showed promise against some of the 7 leaf-eating species used for test purposes. It is expected that a number of these 56 compounds will be of value for commercial use against insect pests of crop plants. Many of them have shown no injurious effects when applied to crop plants in a preliminary way. Three hundred compounds or preparations were tested in this work, including those used in preliminary tests on mosquito larvae.

In cooperation with the Division of Drug and Related Plants of the Bureau of Plant Industry, approximately 800 preparations of plants from Puerto Rico, supposedly fish poisons, were tested for insecticidal value. Except in a few

cases, only those preparations from plants containing rotenone showed indications of effectiveness as insecticides. Tests were also made of several hundred samples of American-grown pyrethrum and preparations from roots of *Cracca virginiana*. These were tested by the biological assay method in connection with plant breeding or selection work under way in the Bureau of Plant Industry. This method makes possible the rapid determination of the insecticidal efficiency of a preparation, being about 20 times as rapid as chemical analysis.

A method of evaluating concentrated fly sprays was developed.

NICOTINE AS A FUMIGANT

In the work with nicotine as a fumigant it has been shown that this insecticide is more effective when used under dry than under humid conditions as formerly supposed, though the humidity at which the insects are held after fumigation apparently has little effect on the efficiency of the treatment. Eight kinds of aphids were used in these tests, and nine other species of insects, including four species of thrips, the housefly, adult codling moths, and silkworm larvae. Much variation in resistance was found, the housefly being very resistant and the aphids very susceptible. The bean aphid was killed with a concentration of two-thirds of a part per million; the adult codling moths and the silkworm larvae were almost as susceptible. Body size and susceptibility of insects to nicotine vapor are not directly related.

A gasoline-driven unit which atomizes nicotine solutions and circulates the fumigant has been tested for aphid control in greenhouses. Toxicity tests show that where approximately the same concentrations of nicotine vapor are used, the cost for material for treatment by this method is about one-half that of some of the other well-known methods. It is planned to put this method on a commercial basis as soon as possible.

In physiological studies on the effect of nicotine on insects it has been shown that the primary effect of nicotine is on the nervous tissue of the insect's heart mechanism; and in comparing two insects it was indicated that in the southern armyworm, where heart nerves have not been found, the effect was much less apparent than it was in the roach, where heart nerves are present.

RECORDING VOLUME AND AMPLITUDE OF THE INSECT HEARTBEAT

In this work a method was devised for amplifying the heartbeat of an insect, and recently a special cardiographic camera has been developed for making permanent records of the volume and amplitude of the insect heartbeat. With this apparatus it is possible to study the effect of various types of insecticides or pharmacological compounds on the insect heart and make accurate records of their effect so that comparisons can be made. This apparatus opens a new field of investigation, and the results of this work will lead to a better understanding of the effect of insecticides on insects.

DIGESTION AND ABSORPTION IN SOUTHERN ARMYWORM

In studies on digestion and absorption in the southern armyworm, it has been found that pyrethrum, which is an excellent insecticide against many insects, loses its toxicity in the digestive tract of the larvae, whereas rotenone, the main toxic constituent of derris root, passes through the digestive tract with toxicity against mosquito larvae practically unchanged. Incubation of these insecticides with various tissues and organs taken from the larvae results in little or no decrease of toxicity in the rotenone but an appreciable detoxification of the pyrethrum, as tested against mosquito larvae. This helps explain the ineffectiveness of these insecticides against this insect and indicates an explanation of its behavior in other cases. A chemical analysis of the blood of the southern armyworm has been made as a preliminary to further tests on the absorption of food products, insecticides, or other substances from the alimentary tract. About 30 blood constituents were quantitatively determined. It is of interest to note that while copper is found in appreciable quantities in both organic and inorganic combination, apparently no oxygen-transporting or respiratory pigment is present in the blood of this insect. This is contrary to the assumption with regard to certain other insects.

REFRIGERATOR CARS AS FUMIGATION CHAMBERS

The ordinary refrigerator car has been shown to be a very effective fumigation chamber, and fumigations of vetch seed against the vetch bruchid, applied in the car under commercial conditions, have given a complete kill. As a matter of fact, the cars were found to be more satisfactory than many fumigation chambers, though good results are obtained in tight vaults.

METHYL BROMIDE AS A FUMIGANT

In cooperation with other divisions of this Bureau, methyl bromide, which has only recently been suggested as a fumigant, has been tested against various insects and with various types of plant products, especially fresh fruits and vegetables and greenhouse plants. It has been used with lima beans, eggplants, cucumbers, green string beans, sweetpotatoes, cantaloups, peppers, tomatoes, and potatoes, in concentrations sufficient to kill the Japanese beetle in the packages, without injury to the product.

Methyl bromide has been tested on loads of 25 bushels or more of green string beans packed in hampers and was found to be effective in killing the Japanese beetle at the center of the package at concentrations of 1½ to 2 pounds of methyl bromide per 1,000 cubic feet of space without injury to the beans. In experimental treatments a dosage of 3 pounds has frequently been used without injury.

Eight different varieties of strawberry plants with soil on roots, packed in crates ready for shipment to market and infested with larvae of the Japanese beetle, were fumigated with methyl bromide. In all cases complete mortality of the larvae was obtained, and the plants grown in the field with appropriate checks showed no evidence of injury. This treatment will materially reduce the cost of disinfesting millions of strawberry plants, which was formerly done by inspecting plants one by one and removing the beetles by hand.

In preliminary experiments with methyl bromide in the fumigation of peach trees for controlling the oriental fruit moth there was complete mortality of the insect with no apparent injury to the nursery stock. Thirty-one greenhouse plants were fumigated with a dosage of 3 pounds of methyl bromide per 1,000 cubic feet without injury, with practically a complete kill of three varieties of aphids, the common red spider, one species of thrips, two species of mealybugs, and immature stages of the southern armyworm. Methyl bromide gives promise of being a good greenhouse fumigant at a temperature of 65° F.

Special apparatus has been devised for introducing methyl bromide and other fumigants into refrigerator cars for the fumigation of carloads of produce without loss of the gas and with a good mixing of the gas in the car.

LOW-TEMPERATURE TREATMENT OF GRAPES FOR MEDITERRANEAN FRUITFLY

During the year it was shown that the low-temperature treatment for the Mediterranean fruitfly could be applied by cooling the fruit in a pre-cooling plant on shore and holding it at a temperature of 34° F. or slightly below that temperature for the required 12 days in the hold of a ship in transit. In this work the fruit (grapes) was cooled at Capetown, South Africa, and loaded on a ship, and the remainder of the treatment was applied en route to Southampton, England. Temperature-measuring instruments in the hold of the ship made possible an accurate determination of the temperature of the fruit by an observer who accompanied the shipment. By this method the importation of grapes from countries in which the Mediterranean fruitfly is found can be safely made to the United States, provided the conditions are such that treatment is properly applied.

INSECTICIDE INVESTIGATIONS

The only change in set-up of the investigations on insecticides since the last annual report was the closing of the laboratory at Wooster, Ohio. The study of the characteristics and effectiveness of oil emulsions which was under way there was discontinued, and the chemist concerned was transferred to Beltsville, Md., where he is developing stickers for use with phenothiazine, nicotine-peat, and other organic insecticides which have been found insufficiently adhesive of themselves.

Forty-six articles were published, mostly in journals outside the Department. Eight patents on various new insecticides and methods of making them, and on new washing solutions for removing insecticidal spray residues from apples, were granted members of the Division. The monthly review of United States patents relating to pest control was issued regularly throughout the year and was sent to 1,133 American and 233 foreign entomologists.

CHEMICAL INVESTIGATIONS ON INSECTICIDAL PLANTS (TOBACCO, DERRIS, PYRETHRUM, ETC.) AND THEIR CONSTITUENTS

Studies on the chemistry of pyrethrum flowers have been continued. Pyrethrum flowers are used in the manufacture of household insecticides intended for combating flies, fleas, mosquitoes, roaches, etc., in cattle sprays, and in dusts for the treatment of celery, cabbage, and numerous other crops. From 10,000,000 to 15,000,000 pounds of this important insecticide are imported yearly, and it is highly desirable to know more about its chemistry. One of the objects of these studies is the isolation of pure pyrethrin I and pure pyrethrin II in order that their relative insecticidal efficacies can be studied. Methods were worked out for obtaining the semicarbazone of pyrethrin II in pure form, but no scheme could be found for hydrolyzing this compound to yield pure pyrethrin II. The semicarbazone of pyrethrin I, on the other hand, is always obtained quite impure, and it was finally determined that it is always accompanied by some of the semicarbazone of pyrethrin II, and by the semicarbazone of pyrethrolone esters of palmitic and linoleic acids. Attempts to regenerate pyrethrin II from pyrethrolone and chrysanthemum dicarboxylic acid yielded a product not identical with natural pyrethrin II. It was found further that the spatial configuration of pyrethrolone is the same whether obtained from pyrethrin I or pyrethrin II, and that the pyrethrins can be cleaved by catalytic hydrogen with the formation of dihydrojasmone, a perfume. Extensive studies were carried out on the nature of the side chain of pyrethrolone, which is important because of the marked specificity of the pyrethrins to insects. The exact position of the double bonds was not demonstrated conclusively, but the evidence favors an allene system rather than a conjugated system.

The question of the presence of nicotine and other alkaloids in species other than *Nicotiana tabacum* was further investigated. It was discovered that *N. sylvestris* contains l-nornicotine. This plant is the only known source of this alkaloid, which is more toxic than nicotine and hence of insecticidal interest. A study of *N. debneyi* revealed the presence of anabasine and nicotine. It became necessary to study the separation of nicotine from the other alkaloids, and a method involving distillation of aqueous solutions was developed for separating anabasine and nicotine with great accuracy. The preparation and properties of nicotine-peat were studied further, 1,200 pounds being prepared in the Department's laboratories for field use of the Bureau during the present season. The greater stability of nicotine tannate over nicotine sulphate was demonstrated by residue studies, and a rather rapid decomposition of nicotine by air was demonstrated. Two articles describing a gravimetric microchemical method for determining small amounts of nicotine were published. In addition, for a study of the evolution of nicotine from dusting mixtures containing it, there was developed another new microchemical technique involving titration of the nicotine with silicotungstic acid, the end point being recognized as the point of maximum turbidity as measured by a photoelectric device.

The question of rotenone and plants bearing it was again given considerable attention. The work of devising a satisfactory method of determining rotenone was brought to conclusion; the crystallization procedure was described in a published article, and the details of the extraction procedure are now in manuscript form. In addition, a possible new analytical procedure, involving a chemical estimation of the rotenone rather than its separation by crystallization, was developed and is being tested. The solubility of rotenone was determined in 53 commercial organic solvents not heretofore reported upon. The physical properties of the complex which rotenone forms with carbon tetrachloride were investigated, because of the importance of this compound in the analysis of derris and cube.

The study of the retardation of the decomposition of derris was continued. Out of 116 spray combinations studied in the laboratory, the 15 that showed some promise from the chemical point of view were prepared for careful insecticidal testing during this summer.

Certain other insecticidal plants and their active constituents were studied. The active material in quassia wood was found to contain two isomeric materials called quassin and neoquassin, and much information was obtained toward determining their structures. Another isomeric material, picrasmin, was obtained from picrasma wood, and its close relationship to quassin demonstrated. The study of *Haplophyton cimicidum* was concluded, without any very definite results. An active principle designated helenalin was obtained from *Helenium autumnale* and another one called tenulin from *H. tenuifolium*, and both materials were studied as to structure.

CHEMICAL INVESTIGATIONS TO DEVELOP SNYTHETIC ORGANIC INSECTICIDES

Over 100 organic compounds were synthesized and sent out for insecticidal testing, mainly against codling moth larvae, mosquito larvae, cabbage-infesting caterpillars, the tobacco hornworm, and the Japanese beetle. Several showed sufficient activity to warrant the filing of patent applications covering them and the classes to which they belong. One patent covering aryl thioxins (phenothioxin) was obtained.

The attempt to better adapt phenothiazine to field work was continued. Its high toxicity to codling moth larvae is admitted, but its application is rendered difficult by its poor wettability, and the deposits do not adhere very well. Laboratory tests have shown that a heavier deposit of phenothiazine is obtained when it is mixed with calcium chloride and soap, which produce a sticky calcium soap capable of holding the phenothiazine. The conditions of exposure which lead to the decomposition of phenothiazine were studied.

CHEMICAL INVESTIGATIONS ON THE REMOVAL OF SPRAY RESIDUE

The removal of lead arsenate from apples was again studied in detail at the Washington, D. C., laboratory. Fruit of several varieties, and sprayed in several ways, was washed with various solutions at several temperatures and in three kinds of machines. A total of 502 samples were analyzed. Residues were lighter in general than in the previous year, and were more easily removed. A varietal effect on ease of removal was evident, and delay after picking caused trouble. The effect of mineral oil in building up of deposit, and in the hindering of washing, was again demonstrated, as was the superiority of the brush-flood machine. A study of 48 of the samples failed to show any significant change in the ratio of lead to arsenic, previously claimed by other investigators. At the Yakima laboratory 132 samples of apples coming from spray plots that had received cryolite were analyzed for fluorine residues, and by the use of the analytical methods developed by the Food and Drug Administration it was demonstrated for the first time in our work that these residues can be satisfactorily removed by efficient washing equipment. At the Vincennes, Ind., laboratory it was demonstrated that lead arsenate residues from first-brood cover sprays are more difficult to remove than those from the second-brood sprays, regardless of the quantity of residue present at harvest, and that the use of adhesives with or following lead arsenate sprays complicates residue removal.

The results of the study of the lead content of chewing tobacco and snuff, presumably residues from the insecticidal dusting of tobacco, were published.

A method of estimating phenothiazine spray residues was developed. It was shown at Yakima that the spray procedures giving good control of codling moth larvae were those that deposited over 20 micrograms of phenothiazine per square centimeter of apple surface, and that such residues can be easily removed by washing. Also, it was shown that phenothiazine residues decompose somewhat from exposure to heat and light, a change that seems to be accelerated by oils, waxes, and finely divided materials such as bentonite.

A method of determining boron in rice dusted with borax was worked out, and the treated rice was shown to contain from 5 to 200 parts of boric acid per million. It was demonstrated that the removal of the hull in the polishing process also removed the greater part of the residue.

A microchemical method for determining antimony was developed to the point where it is suitable for the study of the spray residues resulting from the use of tartar emetic against fruitflies. It resembles the Gutzeit method for arsenic, and determines from 25 to 150 micrograms of antimony. Inci-

dentally, certain features of the Gutzeit method for arsenic were improved, and they may be useful in further improving the antimony method just mentioned.

CHEMICAL INVESTIGATIONS TO DEVELOP INORGANIC INSECTICIDES

Last year's report described the work on commercial calcium arsenate which showed how complex this important insecticide is, and how that complexity is the result of failure to reach equilibrium in the manufacturing process. This year attention was devoted to the development of a method of preparing calcium arsenate so that equilibrium will result in every case, and the composition of the resulting product therefore be predictable from the proportions of lime and arsenic acid used. It was found that by atomizing the acid into the lime slurry while the latter was violently agitated, the local excesses responsible for disturbed equilibria were prevented, and the finished product turned out every time to be what the phase-rule studies had indicated it should be. It is thought that this method can be adapted to commercial manufacture.

A survey of about 40 of the many brands of dusting and wettable sulphurs on the insecticide market was undertaken and the determination of their physical properties almost completed. Complete particle-size analysis was made on all of them, and, as in the case of the calcium arsenates and paris green already reported on, great differences were found among the various brands. This work is part of the general program of studying the relation between particle size and insecticidal efficacy of dusting and spraying materials. A so-called air classifier was obtained and set up, and with this machine considerable quantities of paris green of definitely different particle sizes have been prepared and offered to cooperating entomologists for toxicity tests.

Much work was done on lead arsenate in relation to its use as a soil insecticide for Japanese beetle grubs. A new and shorter method of sampling treated nursery plots was worked out, and nearly 1,000 samples were analyzed preparatory to retreatment. The uniformity of deposits obtained on grass plots was determined, and a start made on the development of a method of chemical analysis for judging the toxicity of a treated soil rather than merely its arsenic content. The effect of various materials in counteracting the deleterious action of lead arsenate in soil on plants growing therein was studied, and promising results were obtained with certain iron compounds, such as bog iron ore and a commercially available chemical byproduct, ferric hydroxide.

Some work was done on the homologs of paris green, and the possibility demonstrated of preparing such greens directly from vegetable, animal, and fish oils instead of from the acids they contain.

CHEMICAL INVESTIGATIONS ON FUMIGANTS FOR CONTROL OF INSECT PESTS

Much of the work done at Whittier, Calif., on the fumigation of the California red scale on citrus was devoted to the betterment of experimental procedure, and various distinct improvements were worked out. First, the concentration of hydrocyanic acid and the length of exposure necessary to give practically 100-percent kill was determined to be 2.1 milligrams of hydrocyanic acid per liter for 40 minutes. Then a procedure was worked out for preconditioning and postconditioning the experimental fruit under certain definite conditions of temperature and humidity so that the scales can be expected to be in a much more uniform state of activity when fumigated. As a result of this, experimental figures can be duplicated now much better than ever before.

In connection with the work on the fumigation of stored cereal products which is under way at the Manhattan, Kans., laboratory, advances were made in the techinque of fumigation in vacuum vaults. In addition, studies were made of the retention of hydrocyanic acid by flour and by rice, and of the dissipation of the hydrocyanic acid with the lapse of time and upon boiling. Finally, the effect of various fumigants upon popcorn, as evidenced by the bulk of popped corn produced, was studied. Hydrocyanic acid appears to have no effect, carbon disulphide lowers the bulk at the higher concentrations, and ethylene dichloride has a pronounced effect which lessens with the time of keeping the fumigated corn before popping.

A study of the fumigation of vegetables with methyl bromide was undertaken. So far, attention has been devoted to the development of methods of analysis, with special reference to one vegetable, string beans.

Paradichlorobenzene is used as a soil fumigant in combating Japanese beetle grubs in nursery stock, and for its effective use the concentration in the treated soil must be watched. No method for its estimation was available, but one was worked out which appears quite satisfactory for use with soils containing water, peat, leafmold, or cow manure.

CHEMICAL INVESTIGATIONS ON OILS AND OIL EMULSIONS

The principal objective of this project was the comparison of the insecticidal value of certain vegetable oils, namely, peanut, corn, cottonseed, pine, and orange oils, with a commonly used petroleum oil. In tests against mealybugs it was found that the first three were about as good as petroleum oil, and under some conditions might be better, as for instance when used at large dosages. In tests of the same oils against overwintering eggs of the scurfy scale, it was found that the drying property of each oil was an important index of the toxicity, quick drying resulting in lesser efficacy. In the study of the effect of adding toxicants to the oils, it was found that nicotine and nicotine-beta-naphthol improved notably the action of petroleum oil, but did not similarly aid corn oil. Pine oil and orange oil were found to be poor because they volatilized too rapidly to be effective insecticides and were quite active in injuring the plants. Of all the additional toxicants tried, the nicotine and betanaphthol combination seemed particularly worthy of further study.

This project was discontinued near the end of the year, and the personnel transferred to Beltsville for work on the development of stickers.

CHEMICAL INVESTIGATIONS ON ACCESSORY MATERIALS FOR USE WITH INSECTICIDES

An extensive investigation of the wetting and spreading properties of mixtures of various fatty acids with sodium hydroxide and with sodium carbonate was carried on, in order to better understand the action of soaps, which are so often used as emulsifiers in oil emulsions and as wetters and spreaders for other spray materials. It was demonstrated that the surface activity increases fairly regularly with increase in molecular weight of the fatty acid, thus following the properties of foaming and detergency. The spreading power of solutions made with sodium hydroxide was found to be quite sensitive to changes in the acid/base ratio, whereas solutions prepared from sodium carbonate were not, indicating the possibility of stabilizing the action of soaps by the use of the carbonate.

A special study was made of triethanolamine oleate, because of its recent popularity in published spray recommendations. It was found to be a generally effective wetting agent. A somewhat similar study was made of solutions of trimethyl benzylammonium oleate, which has recently become commercially available, and it was found to resemble closely sodium oleate.

A study was made of wetters and adhesives for use with phenothiazine, nicotine-peat, and derris.

TESTS TO DETERMINE TOXICITY OF NEW INSECTICIDAL COMPOUNDS, USING GOLDFISH

The principal work of this project was directed toward the finding of possible relationships between toxicity and chemical constitution, as an aid to the project of developing synthetic organic insecticides. To this end the three isomeric tolyl mercaptans or thiocresols were thoroughly studied. When compared at the points of minimum product of time and concentration, the ortho isomer was found to be 1.19 and the para isomer 2.19 times as toxic as the meta compound, these relationships being practically the same as found previously for the corresponding cresols. The mercaptans are from four to eight times as toxic as phenol, but only one-fortieth to one eighty-fifth as toxic as rotenone. The replacement of the oxygen atom of the cresol molecule with sulphur therefore results in a fourfold increase in toxicity, as compared with a sevenfold increase in changing from phenol to thiophenol.

A study similar to the above was begun with the nitro phenols. Preliminary results show the para isomer to be decidedly more toxic than the ortho compound, as was the case with both the cresols and the thiocresols.

CHEMICAL ANALYSIS OF MISCELLANEOUS COMPOUNDS TESTED AS INSECTICIDES

About 350 samples of insecticidal materials used by other divisions of the Bureau were analyzed as usual to insure that the tests were being made with compounds of normal composition. This led to several investigations of analytical methods, such as a new method for determining wood phenols in tar oils, and the adaptation of the red color test for rotenone to actual analysis of samples received. In the latter case it was found that the color test is fairly well correlated with the rotenone content of powdered roots and hence can serve as at least a rough method of approximation. Ninety-five samples of tobacco were analyzed for the Agricultural Adjustment Administration to guide them in the disposition of large stocks damaged by water in the floods of last spring. A special study of the weathering of codling moth bands, involving 150 samples, was made for the Division of Fruit Insect Investigations. Five hundred and twenty-six samples of leaves from forest trees sprayed from an autogiro with lead arsenate and calcium arsenate were analyzed for the Division of Forest Insect Investigations to guide them in regard to questions of distribution and spread. An extended investigation of the process of soaking gladiolus corms in mercuric chloride solutions for the control of thrips was made in cooperation with the Division of Truck Crop and Garden Insect Investigations, and it was demonstrated that when the usually recommended procedure is used about one-half of the mercury chloride is absorbed by the corms. This shows that the usual practice of employing the same solution for more than one lot of corms may not kill all the insects, and that a different procedure must be developed.

TRANSIT INSPECTION

A heavier movement of nursery stock than has been experienced in recent years was reported by transit inspectors in the spring of 1937 at several of the cities where such shipments are inspected while passing through the railway transfer points. Inspection was carried on at 18 of the more important railway centers of the United States throughout the year, or at nursery-stock shipping seasons. The regular force of 16 full-time inspectors was augmented by the assistance in the spring and fall of from 18 to 25 men from other projects of the Bureau, and from 12 to 15 State inspectors. Such action on the part of the States indicates considerable stimulation of interest in recognition of the value of transit inspection in preventing the entry of pests in shipments from the quarantined areas. During the year 1,250,000 package shipments and over 250,000 carloads of nursery stock and other restricted materials were inspected for compliance with certification requirements of Federal quarantines relating to interstate movement. In addition, 547,000 waybills were checked to determine whether the shipments carried materials the movement of which is restricted by these quarantines. There were 2,678 violations of such quarantines intercepted, consigned to points in every State in the Union, the District of Columbia, and Canada. Most of these shipments were returned to the consignors. During the year 90 live adult Japanese beetles were found at midwestern points in the inspection of carloads of produce from the heavily infested area.

The rule of turning back shipments found to be moving in violation of Federal interstate plant quarantines was modified in the spring of 1937 with respect to quarantines relating to the Japanese beetle and the gypsy moth and brown-tail moth, and a new inspection service was authorized. It has been found that the contents of certain types of shipments, including small home packages free from soil, can be readily examined at the terminals to determine whether they are free from such pests. Transit inspectors have accordingly been personally authorized to inspect specified types of shipments, when practicable, and, if found free from the pest concerned, to affix the required certificate and allow the shipment to proceed. This service, it is believed, in no way weakens the effectiveness of the restrictions established to prevent the spread of pests. The consignors, usually persons unaware of the regulations, are notified of violations committed, and any repetition of failure to obtain the inspection before shipping is met by turning back the second shipment.

Incidental to the regular activities of enforcing Federal domestic quarantines, there were reported to the enforcing organizations other apparent violations which came to the attention of transit inspectors, including 130 relating to intrastate quarantines pertaining to pests on account of which Federal quarantines have been established, several relating to foreign plant quarantines, 3 relating to the Insect Pest Act; approximately 500 relating to postal regulations applying to plant shipments, and many apparent infringements of State nursery inspection regulations.

Knowledge of routing and distribution of shipments, not only in the vicinity of the terminal worked but also at the transfer points over the main connecting lines, is required of transit inspectors. Such wide familiarity with transportation details on the part of the Cincinnati inspector proved invaluable to the public welfare in the 1937 flood disasters, when his services were requested by the local relief agencies, and he was assigned to direct the routing of emergency food shipments into the city and to assist the health authorities in determining the contents of some 900 railway cars caught in the yards, and to assemble the 135 cars of perishables for inspection and disposition.

Table 22 gives data pertaining to shipments intercepted at transit inspection points.

TABLE 22.—*Shipments of nursery stock and other articles intercepted in violation of Federal plant quarantines at transit inspection points, fiscal year 1937*

Station	Shipments intercepted in apparent violation of quarantines relating to—								
	Black stem rust	Gypsy moth and brown-tail moth	Japanese beetle	Pink bollworm	Thurberia weevil	White-pine blister rust	Mexican fruitworm	Dutch elm disease	Total
Atlanta			5				2		7
Boston		68	82			2	1		153
Chicago	6	100	400	3	2	26	94		631
Cincinnatti		2	18			3	9		32
Detroit		23	13				1		37
Indianapolis		3	7				4		14
Jacksonville		2	77						79
Kansas City		3	52	1		8	29		93
New York		292	352			13	3	1	661
Omaha and Council Bluffs	2	11	131			7	4		155
Philadelphia		28	220	2		4	19		273
Pittsburgh	5	3	182			31	15		236
St. Louis		1	26				57		84
St. Paul and Minneapolis		3	22	1		16	29		71
Springfield, Mass		138	13						151
Washington		1							1
Total	13	678	1,600	7	2	110	267	1	[1] 2,678

[1] The total number of violations represents 2,611 shipments, of which 57 were in violation of 2 quarantines and 5 were in violation of 3 quarantines.

TERMINAL INSPECTION OF MAIL SHIPMENTS

The States of California, Montana, and Mississippi availed themselves, during the year, of the provisions of Act No. 643, of June 4, 1936, amending the law relating to the terminal inspection of parcel-post shipments of plants and plant products. These States have established the procedure, through Federal channels, of turning back parcel-post shipments found to be in violation of certain State plant quarantines.

The terminal inspection procedure which has been in effect for several years, and which provides for turning back or disinfecting infested shipments, continues to be maintained in Arizona, California, the District of Columbia, Florida, Hawaii, Idaho, Louisiana, Mississippi, Montana, Oklahoma, Oregon, Puerto Rico, Utah, and Washington.

CONVICTIONS AND PENALTIES IMPOSED FOR VIOLATIONS OF THE PLANT QUARANTINE ACT

The following convictions and penalties imposed for violations of the Plant Quarantine Act were reported to the Bureau during the year:

Gypsy moth and brown-tail moth quarantine: One conviction, with fine of $25.

Japanese beetle quarantine: Two convictions, with fines aggregating $75.

Quarantines affecting Mexican plants and plant products: Fines aggregating $452.85 were imposed by customs officials on the Mexican border against 436 persons caught attempting to smuggle in from Mexico prohibited plants and plant products.

FOREIGN PLANT QUARANTINES

The Division of Foreign Plant Quarantines is engaged in the enforcement of quarantines and regulatory orders of the Department prohibiting or restricting the entry of various plants and plant products into the United States and, in addition, the enforcement of such domestic quarantines as affect the movement of plant material between the Territories of Hawaii and Puerto Rico and continental United States. During the year 20 foreign plant quarantines and regulatory orders, 8 domestic plant quarantines, and 4 miscellaneous regulatory measures were enforced.

Plant-quarantine inspectors and collaborators are stationed at the more important ports of entry and at points distributing foreign mail and work in close cooperation with employees of the Treasury and Post Office Departments.

Detailed information on the various plant quarantines administered by the Bureau is available in other publications. Of particular interest in connection with foreign plant quarantines are the following changes:

Quarantine No. 5, the Mexican fruitfly quarantine, which prohibited the entry into the United States from Mexico of certain known host fruits of the Mexican fruitfly, was lifted, effective December 1, 1936, and the control of entry of the fruits in question thereby became subject to the provisions of Quarantine No. 56, the fruit and vegetable quarantine. The only effect of this action is that certain fruits from Mexico formerly prohibited entry may now be entered frozen or in a processed state under the provisions of Quarantine No. 56.

Effective September 1, 1936, Quarantines Nos. 7 and 20, which had prohibited the entry of five-needle pines, currants, and gooseberries from Europe, Asia, Canada, and Newfoundland, and other pines from Europe, were lifted. The entry of the material formerly covered by these quarantines automatically became subject to the restrictions of the Nursery Stock, Plant, and Seed Quarantine, No. 37. A limited amount of such material was imported under that quarantine, under conditions that would not contribute to the further spread of the blister rust in this country.

Notice was given on July 20, 1936, that, effective August 1, 1936, the entry of seeds of *Lathyrus* and *Vicia* would be subject to the restrictions affecting the entry of other seeds covered by regulation 3 of the Nursery Stock, Plant, and Seed Quarantine, No. 37. Under the provisions of this notice 3,671,709 pounds of vetch seeds were imported from 6 countries and 1,802 pounds of sweet pea seeds from 5 countries.

On December 15, 1936, the entry of narcissus bulbs became subject to the restrictions of regulation 3 of quarantine No. 37, whereas they had been imported, since January 1, 1926, under the provisions of regulation 14 of the same quarantine. The principal effect of this change is to remove the quantity and utilization limits which applied to the importations of these bulbs under the provisions of regulation 14. This modification became effective after the close of the commercial importing season and most of the narcissus bulbs, elsewhere given as imported, entered under regulation 14.

Quarantine No. 56 was amended to provide for the entry of fruits and vegetables which have been treated, or are to be treated, under the supervision of a plant-quarantine inspector of the Department in a manner deemed adequate to eliminate any pest risk. This provision applies especially to frozen fruits and vegetables and to fruits and vegetables subject to low-temperature sterilization.

Effective December 1, 1936, the regulations governing the importation of potatoes into the United States were amended to provide for the entry of potatoes from the entire northern territory of Baja California, Mexico, through both Calexico and San Ysidro, and to eliminate the provision for the unrestricted importation of foreign potatoes into the Territory of Hawaii for local use. Previously, entry of potatoes from Baja California had been limited to those grown in and shipped from the Imperial Valley of the northern territory of

Baja California through Calexico only; and the entry of foreign potatoes had been allowed into Hawaii without restriction when imported for local use.

Effective March 6, 1937, importation of potatoes from Latvia was authorized in accordance with the potato regulations.

MARITIME-PORT INSPECTION

SHIP INSPECTION

Ships from foreign countries and also those from Hawaii and Puerto Rico are inspected promptly upon arrival for the presence of prohibited and restricted plant material in ships' stores, passengers' and crews' baggage, quarters, and in cargo.

The inspection at ports in California, Florida, Hawaii, and at certain ports in Puerto Rico has been performed by State and Territorial officials serving as collaborators of the Bureau of Entomology and Plant Quarantine.

A record by ports of the ship inspection appears in table 23. Following the policy adopted last year, the number of ships carrying restricted plant material is not shown. In previous reports both prohibited and restricted plant material had been reported as contraband. The pest risk involved with most restricted plant material is apparently very small, and for that reason such material has not been considered in this table.

TABLE 23.—*Number of ships inspected, fiscal year 1937*

Port	From foreign ports											
	Direct			Via United States ports			Via Hawaii			Via Puerto Rico		
	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material
Baltimore	728	725	307	788	781	379	1	1	0			
Bellingham	30	30	10									
Boston	1,424	1,423	529	408	407	187				2	2	1
Brownsville	7	7	5	9	9	5						
Brunswick [1]	3	3	2									
Buffalo	7	7	3	1	1	0						
Charleston	208	208	103	152	150	59	1	1	1			
Chicago	5	5	3	11	11	6						
Detroit	26	26	23									
Eureka [2]	2	2	0	4	4	1						
Galveston	278	274	128	468	468	238				2	2	1
Gulfport [3]	21	20	18	105	37	25						
Honolulu [2]	240	240	109	2	2	0						
Houston	427	426	335	437	433	195				1	1	0
Jacksonville [2]	251	251	23	133	133	0				1	1	0
Key West [2]	175	172	72	65	59	1						
Miami [2]	1,381	1,380	419	34	30	14						
Mobile	249	247	106	391	362	187						
New Orleans	1,410	1,410	653	498	498	307				2	2	2
Newport News	82	82	48	419	417	205				1	1	0
New York	3,895	3,809	2,191	1,093	945	444	1	1	0	155	155	105
Norfolk	283	283	153	814	809	372				1	1	0
Pensacola [2]	49	49	26	188	188	87						
Philadelphia	846	845	421	1,079	1,079	608	1	1	1	1	1	1
Port Arthur	326	325	257	324	324	121				7	7	4
Portland, Oreg	69	69	53	270	267	165	1	1	1			
Port San Luis [2]	66	66	14									
Puerto Rico (all ports)	1,013	1,007	353									
San Diego [2]	1,138	1,137	26	24	24	0	2	2	0			
San Francisco [2]	361	361	176	596	596	242	83	83	50			
San Pedro [2]	1,411	1,410	861	363	363	90	72	72	46	15	15	13
Savannah	115	115	68	229	227	128						
Seattle	996	876	137	160	160	91	1	1	1			
Tampa [2]	270	270	88	315	315	95						
Ventura [2]	6	6	1									
West Palm Beach [2]	145	145	5	3	3	0						
Total	17,943	17,711	7,726	9,383	9,102	4,252	163	163	100	188	188	127

TABLE 23.—*Number of ships inspected, fiscal year 1937*—Continued

Port	From Hawaii						From Puerto Rico						From United States ports		
	Direct			Via United States ports			Direct			Via United States ports			Via Panama Canal		
	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material
Baltimore	2	2	0	49	49	1	19	19	1	27	27	0	173	172	6
Bellingham	2	2	1												
Boston				20	20	0	16	16	4				161	161	0
Charleston							8	8	0	19	19	0	40	40	1
Eureka [2]				5	5	0									
Galveston	2	2	0	2	2	1	11	11	2	8	8	0	25	25	0
Gulfport [3]										7	0	0			
Honolulu [2]													100	100	1
Houston	7	7	2	2	2	0	12	12	3	11	11	0	40	40	0
Jacksonville [2]							30	30	0	5	5	0	16	16	1
Miami [2]							2	2	0						
Mobile	1	1	1	4	4	0	29	29	5	53	53	1	45	45	0
New Orleans	12	12	9	10	10	0	22	22	6	76	76	1	51	51	1
Newport News										2	2	0	4	4	0
New York	30	28	2	38	33	0	114	113	12	16	10	1	276	221	3
Norfolk				3	3	0				46	45	1	95	95	0
Pensacola [2]							2	2	0	4	4	0			
Philadelphia	2	2	0	32	32	1	50	50	14	8	8	0	259	259	5
Port Arthur							8	8	2	7	7	0	15	15	1
Portland, Oreg				7	7	1									
Port San Luis [2]	15	14	1												
Puerto Rico (all ports)													15	15	4
San Diego [2]	91	91	10	1	1	0							121	121	10
San Francisco [2]	111	111	33	22	22	2							459	459	6
San Pedro [2]	77	77	15	33	33	7							661	661	81
Savannah				4	4	1	8	8	1	16	16	0	17	15	0
Seattle	2	2	0	1	1	0							2	2	0
Tampa [2]							29	29	2	1	1	0			
Ventura [2]	9	9	1												
Total	363	360	75	233	228	14	360	359	52	306	292	4	2,575	2,517	120

[1] Work handled by inspector stationed at Savannah, Ga. [2] Collaborators stationed at these ports. [3] Work handled by inspectors stationed at Mobile, Ala.

NOTE.—The foreign ship arrivals do not in all cases agree with customs figures. Foreign ships may put in for bunkers and be inspected by inspectors of the Bureau of Entomology and Plant Quarantine but not entered by customs. On the other hand, ships entered at certain small subports are included in customs records but not in this report.

CARGO INSPECTION

All importations of plants and plant products subject to plant-quarantine restrictions are inspected at the port of entry or the port of first arrival. A record of the number of such importations, by ports, appears in table 24.

TABLE 24.—*Inspection of shipments of plants and plant products offered for entry, fiscal year 1937*

Port	Shipments inspected and entered under permit	Shipments refused entry	Port	Shipments inspected and entered under permit	Shipments refused entry	Port	Shipments inspected and entered under permit	Shipments refused entry
	Number	*Number*		*Number*	*Number*		*Number*	*Number*
Baltimore	322	0	Honolulu [4]	557	0	Port Arthur	6	0
Bellingham [1]	208	0	Houston	186	3	Port Huron [4]	75	0
Blaine	300	0	Jacksonville [4]	188	0	Portland	134	2
Boston	2,027	1	Key West [4]	210	0	Presidio	13	0
Brownsville	1,072	0	Laredo	3,229	0	Puerto Rico (all ports)	626	0
Buffalo [2]	1,120	5	Mercedes	17	0	Roma	1	0
Calexico	590	0	Miami [4]	1,120	4	San Diego [4]	5	1
Charleston	149	1	Mobile	207	1	San Francisco [4]	814	17
Chicago	123	4	Naco	8	0	San Pedro [4]	564	0
Del Rio	3	0	New Orleans	2,503	2	San Ysidro	76	0
Detroit	503	12	Newport News	2	0	Savannah	30	0
Douglas	79	0	New York	14,389	71	Seattle	705	1
Eagle Pass	526	0	Nogales	4,869	4	Tampa [4]	1,008	0
El Paso	4,315	0	Norfolk	203	1			
Galveston	206	0	Pensacola [4]	3	0			
Gulfport [3]	7	0	Philadelphia	678	0	Total	44,384	130
Hidalgo	408	0						

[1] Includes entries made at Sumas.
[2] Includes entries made at Niagara Falls.
[3] Work handled by inspectors stationed at Mobile.
[4] Collaborators stationed at these ports.

In addition to the importations credited to the Mexican-border ports, there were several thousand importations of permitted fruits and vegetables which were so small that no duty was assessed by customs and no record of them kept. All of these small importations, however, were carefully inspected before being released.

At certain ports considerable time was devoted to the inspection of miscellaneous cargoes to determine their true status. Many inspections were also made of packing material used with various commodities, to determine compliance with quarantine No. 69. Some time was also devoted to the supervision of the cleaning of shipments contaminated with objectionable material such as soil.

The inspections recorded in table 24 cover plants and plant products imported under the provisions of plant quarantines and regulations as follows:

Regulation 3 of quarantine No. 37: 158,681,159 bulbs, corms, and rootstocks, including *Convallaria, Crocus, Hyacinthus,* and *Lilium;* 11,227 fruit and nut cuttings, scions, and budsticks; 6,374,790 rose stocks; 85,850 pounds and 2,142 small mail packages of tree and shrub seeds; 3,671,709 pounds of vetch seed; 367,228 pounds of onion sets; 99 test tubes of orchid seedlings; and 347 pounds of miscellaneous propagating material.

Regulation 14 of quarantine No. 37: 6,148,044 bulbs and corms, including 1,884,653 *Gladiolus,* 3,389,193 *Iris,* and 643,902 *Narcissus;* 54,007 plants, bud sticks, and cuttings of a ligneous nature (mostly woody ornamentals), including 10,631 roses; 13,058 dahlia roots; 45,985 orchid plants; 36,575 cactus plants and cuttings; and 365,117 miscellaneous plants, cuttings, etc., not otherwise counted.

Regulation 15 of quarantine No. 37: 155,177 bulbs and corms, including 154,583 *Gladiolus*; 435,396 trees and shrubs, including 17,978 roses; 5,086 dahlia roots; 30 square yards of sod; and 44,648 plants, cuttings, etc., not otherwise counted. Through cooperation of the customs officers stationed at ports of entry along the Canadian border and of the Division of Foreign Pests Suppression, Department of Agriculture of the Dominion of Canada, entry of material

under this regulation was made with adequate safeguards at 27 border ports at which plant-quarantine inspectors are not stationed, as well as at 10 ports where there are inspectors.

Cotton regulations: Cotton, including linters, 360,104 running bales; cotton waste, 210,701 running bales; bagging (second-hand) including cotton-contaminated rags, 205,965 running bales.

Cottonseed products regulations: Cottonseed cake, 18,355,095 pounds; cottonseed meal, 27,639,228 pounds; cottonseed-meal fertilizer, 16,805,532 pounds; mixed feed, including cottonseed cake, 29,919 pounds; cottonseed oil, 43 gallons.

Quarantine No. 8: Cottonseed hulls, 17,196,780 pounds; bolly hulls, 5,127,560 pounds.

Quarantines Nos. 15 and 16: Bagasse, 11,805 pounds.

Quarantine No. 24: Corn, shelled, 5,359,227 pounds.

Quarantine No. 28: Oranges (mandarin), 1,595,724 pounds.

Quarantine No. 41: Corn, shelled, 4,502,799,855 pounds; mixed feed containing shelled corn, 22,220 pounds; corn fodder, 34,000 pounds; corn on the cob, 332,159 pounds; sorghum seed, 4,266 pounds; jobs-tears, 22 pounds; broomcorn, 10,031 bales and bundles; brooms made of broomcorn, 27,257.

Quarantine No. 55: Paddy rice, 93,168 pounds; rice straw, 1,656 bales.

Quarantine No. 56: Bananas 61,940,762 bunches; plantains, 16,192,486 pounds; pineapples, 1,453,670 crates; avocadoes, 10,520,484 pounds; eggplants, 6,342,510 pounds; garlic 7,447,837 pounds; grapes, fresh (not hothouse), 12,966,553 pounds; grapefruit, 8,697,801 pounds; limes, sour, 12,863,643 pounds; peppers, 8,688,265 pounds; tomatoes, 99,346,550 pounds; all other, 93,256,566 pounds.

Potato regulations: Potatoes, 1,971,128 pounds.

PLANTS AND PLANT PRODUCTS ENTERED FOR IMMEDIATE EXPORTATION OR FOR TRANSPORTATION AND EXPORTATION

In addition to plants and plant products affected by the plant quarantines and regulatory orders of the Department which are offered for consumption entry, many products are offered for transportation in bond through the United States and are exported through other ports. Among these are large shipments of Mexican fruits and vegetables entered through Mexican-border ports and exported through ports along the Canadian border. Other shipments arrive at United States ports of entry and are immediately exported therefrom when transportation to their foreign destination is available. Among the products offered for transportation and exportation or for immediate exportation during the year were 117 shipments of nursery stock; 196,424 bales of cotton lint, linters, and waste; 687 bales of bagging; 17,389,947 pounds of cottonseed cake and meal; 25,600 pounds of wheat; 3,313,464 pounds of corn; and 58,145,231 pounds of fruits and vegetables.

With respect to the importation of fruits and vegetables, it should be stated that many shipments which are offered for transportation and exportation in bond are later diverted to points in the United States where consumption entry is made. For that reason shipments of this character require the same care in inspection as shipments offered for consumption entry.

DISINFECTION

Disinfection is required of certain commodities as a condition of entry and of other commodities when inspection reveals the presence of injurious insects or plant diseases. During the year the following plant material was treated under supervision of inspectors of this Bureau: Cotton, 235,408 bales; cotton waste, 117,898 bales; cotton linters, 68,284 bales; parcels of cotton, cotton waste, and bagging, 3,269; bagging, 554 bales; rags contaminated with cottonseed, 1,055 bales; broomcorn, 10,336 bales; rice fiber, 2,116 bales; chestnuts, 1,794 cases; cipollini, 108 cases; corn, 1,000 sacks; vetch seed, 5,877 sacks; other seeds, 88 containers; miscellaneous plants, 598 lots; narcissus bulbs, 371,939; and bulbous iris, 567,351.

In addition to the above, various shipments of plant material and cotton samples were treated at the inspection house in Washington, D. C., as shown in table 27.

AIRPLANE INSPECTION

The importance which the airplane has assumed as a possible means of introducing plant pests is clearly shown by the inspection records for the year. A total of 3,321 airplanes were inspected at the following 17 ports of entry: Douglas and Nogales, Ariz.; Calexico, Los Angeles, San Diego, and San Francisco, Calif.; Miami and West Palm Beach, Fla.; Honolulu, Hawaii; Baltimore, Md.; New York, N. Y.; Philadelphia, Pa.; San Juan, P. R.; Brownsville, El Paso, and Laredo, Tex.; and Seattle, Wash. As a result of these inspections, 1,505 interceptions of prohibited and restricted plant material were taken from 920 airplanes.

These figures represent an increase of approximately 11 percent in the number of airplanes inspected and 29 percent in the number of interceptions made over the fiscal year 1936.

FOREIGN PARCEL-POST INSPECTION

Through cooperation with customs and post-office officials, mail packages from foreign countries which are found to contain plants or plant products are referred to inspectors of this Bureau for examination. Such packages arriving at ports of entry where no plant-quarantine inspectors are stationed are forwarded to the nearest port where inspection can be made.

This activity has continued to increase, as indicated by the total number of packages inspected at all ports, 249,583, as compared with 191,740 for the fiscal year 1936. A record, by ports, of the number and disposition of foreign parcel-post packages inspected appears in table 25.

TABLE 25.—*Foreign parcel-post packages inspected, fiscal year 1937*

Port	Inspected	Refused entry (entire or in part)	Diverted to Washington	Port	Inspected	Refused entry (entire or in part)	Diverted to Washington
	Number	*Number*	*Number*		*Number*	*Number*	*Number*
Atlanta [1]	157	1	120	Miami [1]	154	37	12
Baltimore	2,103	34	238	New Orleans [5]	266	14	83
Boston	5,389	63	2,020	New York	170,986	554	10,115
Brownsville	1,211	6	3	Nogales [6]	656	10	4
Buffalo	1,743	22	316	Philadelphia	8,414	91	849
Chicago	20,893	252	747	Portland [7]	401	11	0
Detroit	4,765	91	146	Puerto Rico (all ports)	53	18	0
Eagle Pass	356	0	0	St. Paul	15,234	40	71
El Paso [2]	687	57	12	San Diego [1] [8]	87	8	1
Galveston	1	1	0	San Francisco [1]	5,145	112	16
Honolulu [1]	1,703	212	0	Seattle	2,017	64	7
Houston	138	12	117	Tampa	5	0	2
Jacksonville [1]	113	17	11	Washington	1,497	24	--------
Laredo [3]	477	51	70				
Los Angeles [1] [4]	4,932	101	8	Total	249,583	1,903	14,968

[1] Collaborators are stationed at these ports.
[2] 78 packages were diverted to San Francisco for disposition.
[3] 31 packages were diverted to San Francisco for disposition.
[4] 168 packages were diverted to San Francisco for disposition.
[5] 3 packages were diverted to San Francisco for disposition.
[6] 7 packages were diverted to San Francisco for disposition.
[7] 7 packages were diverted to Seattle for disposition.
[8] 1 package was diverted to San Francisco for disposition.

Following the policy which was adopted some years ago, shamrocks, which are permitted entry through the mails provided they are free from soil, are included in table 25.

Of the number of packages listed as inspected, the following represent shamrocks: Baltimore, 39; Boston, 1,685; Buffalo, 30; Chicago, 5,681; Detroit, 47; Los Angeles, 79; New York, 45,612; Philadelphia, 1,005; St. Paul, 25; San Francisco, 49; Seattle, 95.

There is a marked tendency toward a greater use of the mails for shipping nursery stock and other plants and seeds to this country under the provisions

of quarantine No. 37. Although the relatively large proportion of the importations from Canada and Mexico consist of baggage and cargo shipments, for which the mail-entry procedure is unsuitable (thus tending to keep the percentage of total mail shipments at a relatively low figure), 53 percent of all importations under quarantine No. 37 came by mail. Only 12 percent of the bulb shipments, under regulation 3 of quarantine No. 37, arrived by mail, but 90 percent of all other importations under that regulation were imported by that means. Of the importations entered under regulations 14 and 15 of the same quarantine, 59 percent and 12 percent, respectively, entered through postal channels.

MEXICAN-BORDER SERVICE

With the improvement in economic conditions and the completion of important highways in Mexico, there has been a decided increase in the amount of travel between Mexico and the United States. This increase in traffic is reflected in the increase in the vehicular and baggage inspection at certain ports during the year and also in the number of interceptions of prohibited and restricted plant material. The number of freight cars entering from Mexico increased from 27,259 in the fiscal year 1936 to 32,050 in 1937; likewise, there was an increase in the number of cars contaminated with cottonseed from 1,479 the previous year to 2,034 this fiscal year. The number of railway cars fumigated increased from 8,181 in the fiscal year 1936 to 8,226 in 1937. All railway cars found to be contaminated with cottonseed were required to be cleaned before entry was permitted. The usual fee of $4 was charged for each car fumigated and all fees collected were covered into the Treasury as miscellaneous receipts.

A summary of the railway-car inspection and fumigation is shown in table 26. In addition to the freight cars listed in this table, 4,123 Pullman and passenger coaches entered and were inspected at the following ports: Eagle Pass, 8; El Paso, 1,160; Laredo, 2,487; Nogales, 465; and Presidio, 3.

TABLE 26.—*Inspection and fumigation of railway cars crossing the border from Mexico, fiscal year 1937*

Port	Cars inspected	Cars with cottonseed	Cars entered	Cars fumigated	Fees collected
	Number	*Number*	*Number*	*Number*	*Dollars*
Brownsville	1, 261	2	1, 258	53	212
Douglas	1, 666	3	1, 666	60	240
Eagle Pass	2, 276	177	2, 209	908	3, 700
El Paso	7, 760	142	7, 333	[1] 1, 177	4, 520
Laredo	12, 078	1, 520	11, 116	4, 606	18, 924
Naco	716	21	716	3	12
Nogales	7, 727	147	7, 451	1, 366	5, 400
Presidio	306	22	301	53	212
Total	33, 790	2, 034	32, 050	8, 226	[2] 33, 220

[1] Includes 29 cars not from Mexico.
[2] The apparent discrepancy in fees collected and the number of cars fumigated may be explained by the fact that it is customary for the railroads to purchase fumigation coupons in advance.

Plant-quarantine inspectors at Mexican-border ports take an active part, in cooperation with the customs service, in the inspection of vehicles, baggage, personal effects, and express packages from Mexico. A total of 315,736 pieces of baggage and 3,795,609 vehicles were inspected. This inspection resulted in the interception of large quantities of prohibited and restricted plant material, a record of which may be found in table 29.

INSPECTION IN PUERTO RICO AND HAWAII

The inspectors stationed in Puerto Rico enforce the provisions of quarantine No. 58, governing the movement of fresh fruits and vegetables to the mainland, in addition to the enforcement of foreign plant quarantines and regulations

as they affect the entry of foreign plants and plant products into the island. Insular inspectors serving as collaborators render valuable assistance, especially in that portion of the work pertaining to the enforcement of the foreign plant quarantines.

Inspections are made in the fields, in packing houses, and on the docks of such fruits and vegetables as are permitted to move to the mainland under the provisions of quarantine No. 58. During the year 2,817 shipments, consisting of 35 bunches of bananas, 519,631 crates of pineapples, and 17,166,620 pounds of other approved fruits and vegetables were certified for such movement.

Inspection is also made of parcel-post packages originating on the island and destined for points in continental United States. Through cooperation with post-office officials, arrangements were made to carry on this inspection at the four main post offices on the island. This arrangement has increased considerably the efficiency of this phase of the work and has also greatly reduced the number of Puerto Rican mail packages requiring inspection upon arrival at New York. A total of 5,053 packages were examined in the San Juan office, and 337 were found to contain prohibited plant material and were returned to the sender. Inspection figures for the post offices in Mayaguez, Ponce, and Arecibo are not available.

In Hawaii the enforcement of foreign plant quarantines is handled wholly by insular inspectors serving as collaborators. The inspectors of this Bureau stationed in the Hawaiian Islands are engaged in the enforcement of quarantine No. 13, which governs the movement of fresh fruits and vegetables to the mainland. Inspections are made in the fields, packing houses, and on the docks of such fruits and vegetables as are permitted to move to the mainland under the provisions of quarantine No. 13. During the year, 1,728 shipments, representing 71,189 bunches of bananas, 39,443 crates of pineapples, and 3,712,002 pounds of other approved fruits and vegetables, were inspected and certified.

It is necessary to devote considerable time to the inspection of parcel-post packages originating in Hawaii and destined for mainland points. During the year 102,564 such packages were opened and examined and the plant quarantine status of 163,844 packages was determined by other means; 56 packages were found to contain prohibited plant material.

Inspection and sealing of baggage of travelers between Hawaii and the mainland were continued. A total of 3,485 pieces of baggage were safeguarded in this manner.

On November 1, 1936, the inspection and clearing of airplanes bound for mainland ports was inaugurated at the Pearl City airport and on April 10, 1937, inspection of shipments of plant material from Hawaii to the mainland by air express was commenced. This inspection not only avoids delay upon the arrival of the airplanes at the mainland, but also is a decided advantage from the standpoint of pest risk.

INSPECTION OF SPECIAL-PERMIT AND DEPARTMENTAL PLANT MATERIAL

Importations of propagating plant material are inspected at special ports of entry designated for that purpose. Most of these special-permit importations are inspected and treated at the inspection house at Washington, D. C. In addition to special-permit importations, departmental importations and plant propagating material distributed by the Department are likewise inspected at the Washington, D. C., inspection house. The inspection-house staff at Washington also inspects and certifies for interstate shipment commercial shipments of nursery stock, in order that such shipments may meet the certification requirements of the various States. Table 27 gives a summary of inspections and treatments of nursery stock at the Washington, D. C., inspection house during the year.

TABLE 27.—*Summary of plants and plant products offered for inspection in the District of Columbia, fiscal year 1937*

Material inspected	Foreign	Domestic	Fumigated	Otherwise treated	Infested with insects	Infected with diseases
Lots of seeds (departmental)	8,137	9,776	6,944	1,150	656	172
Plants, cuttings, bulbs, roots, rhizomes, etc. (departmental)	11,121	150,495	3,158	3,051	[1] 250	[1] 183
Miscellaneous unclassified material, other than plants and seeds (departmental)	300	365	88	11	7	7
Shipments of plants under regulation 14, quarantine No. 37 (commercial)	2,409	--------	405	152	571	485
Shipments of plants and plant products under regulations 3 and 15, quarantine No. 37 (commercial)	1,260	--------	214	111	148	26
Containers of domestic plants other than departmental (mail, express, freight, and truck)	--------	11,707	1	6	13	4
Shipments of plants by private individuals	--------	5,351	15	28	55	14
Interceptions of plants and plant products at Washington, D. C	1,497	3	36	72	96	--------
Interceptions of plants and plant products referred to Washington, D. C	1,495	1	112	996	111	4
Parcels of cotton samples referred to Washington, D. C	25,319	--------	25,319	--------	--------	--------

[1] Lots.

INSPECTION OF PLANT-INTRODUCTION AND PROPAGATING GARDENS

The Bureau is charged with the responsibility of inspecting plant material at the plant-introduction gardens maintained by the Bureau of Plant Industry where plant introductions are observed and are propagated for distribution. Plant material distributed from the plant-introduction garden at Coconut Grove, Fla., was inspected by State officials cooperating with this Bureau. Plant material shipped from the Chico, Calif., gardens was inspected jointly by an inspector of the Bureau and an entomologist from the California State Department of Agriculture. Material distributed from the District of Columbia and Savannah, Ga., was inspected by inspectors of the Bureau. A summary of the inspections of these plant distributions appears in table 28.

TABLE 28.—*Plants, budsticks, cuttings, tubers, roots, and shipments of seeds examined for distribution from plant introduction and propagating gardens, fiscal year 1937*

Station	Plants	Budsticks, cuttings, tubers, and roots	Shipments of seeds	Station	Plants	Budsticks, cuttings, tubers, and roots	Shipments of seeds
Bell, Md	29,840	1,025	3	Savannah, Ga	1,554	677	4
Chico, Calif	8,337	721	66	Washington, D. C	8,037	10,185	23,939
Coconut Grove, Fla	5,633	1,271	28				
Mandan, N. Dak.[1]	0	0	0	Total	53,401	13,879	24,040

[1] Owing to drought no shipments were made.

INTERCEPTIONS OF PROHIBITED AND RESTRICTED PLANTS AND PLANT PRODUCTS

The inspection of ships, vehicles, cargo, baggage, ships' stores, and quarters, and foreign mail at the maritime and Mexican-border ports resulted in the interception of large quantities of prohibited and restricted plant material. Many of these interceptions were found to harbor insect pests and plant diseases; many others, while showing no infestation or infection, must be considered potentially dangerous, since they are known hosts of pests in the country of origin. In classifying the interceptions, those made at bridges, ferries, and crossings at the Mexican and Canadian border ports have all been considered as having been taken from baggage.

A record of the number of interceptions of prohibited and restricted plant material appears in table 29.

TABLE 29.—*Number of interceptions of prohibited and restricted plants and plant products, fiscal year 1937*

Port	In baggage		In cargo		In mail		In quarters		In stores		Total	
	Prohibited	Restricted	Prohibited	Restricted	Prohibited	Restricted	Prohibited	Restricted	Prohibited	Restricted	Prohibited	Restricted
Baltimore	11	15	43	0	38	0	85	8	189	4	366	27
Bellingham	5	10					0	4	3	2	8	16
Blaine	1,059	631									1,059	631
Boston	77	142	4	1	25	42	7	6	10	1	123	192
Brownsville	7,027	1,136			3	3					7,030	1,139
Buffalo [1]	2	360	0	1	9	13					11	374
Calexico	1,841	123									1,841	123
Charleston	13	2	1	0			41	0	30	0	85	2
Chicago			8	0	178	90					186	90
Del Rio	584	83									584	83
Detroit	139	395	3	12	84	29					226	436
Douglas	499	55									499	55
Eagle Pass	1,657	213									1,657	213
El Paso	7,208	942			43	21					7,251	963
Galveston	12	3	1	0	1	0	212	11	24	2	250	16
Gulfport [2]	2	2					11	0	7	1	20	3
Hidalgo	2,242	271									2,242	271
Honolulu [3]	888	258	62	10	187	5			34	1	1,171	274
Houston	4	5	3	0	3	0	433	0	57	0	500	5
Jacksonville [3]					16	0	5	5	17	4	38	9
Key West [3]	86	181					3	1	9	2	98	184
Laredo	15,249	1,347			40	11					15,289	1,358
Los Angeles [3]	4	1	1	7	79	24	4	0			88	32
Mercedes	251	42									251	42
Miami [3]	1,755	450	46	11	27	10	1,016	212	86	11	2,930	694
Mobile	9	3	7	8			127	3	78	4	221	18
Naco	124	44									124	44
New Orleans	444	240	11	19	9	7	843	29	112	7	1,419	302
Newport News							17	0	2	0	19	0
New York	1,815	1,353	514	160	384	75	235	44	139	10	3,087	1,642
Nogales	2,502	813			3	6					2,505	819
Norfolk	3	3	3	0			141	70	45	2	192	75
Pensacola [3]	3	0					24	0	19	0	46	0
Philadelphia	20	7	11	1	66	22	99	43	137	23	333	96
Port Arthur	24	0	1	0			569	2	90	0	684	2
Port Huron [3]	1	138									1	138
Portland			4	0	9	2			8	0	21	2
Presidio	289	45									289	45
Puerto Rico (all ports)	121	46					2	0	1	0	124	46
Roma	173	24									173	24
St. Paul					24	18					24	18
San Diego [3]	8	5			3	0	13	2	46	5	70	12
San Francisco [3]	247	15	21	5	49	58	229	22	122	15	668	115
San Pedro [3]	557	38	4	0			48	0	145	9	754	47
San Ysidro	5,042	584									5,042	584
Savannah							92	1	12	2	104	3
Seattle	81	37	1	0	24	2	1	0	2	0	109	39
Tampa [3]	16	10	1	0			15	7	14	1	46	18
West Palm Beach [3]							6	2	0	1	6	3
Total	52,094	10,072	750	235	1,304	438	4,278	472	1,438	107	59,864	11,324

[1] Includes interceptions made at Niagara Falls.
[2] Work handled by inspectors stationed at Mobile.
[3] Collaborators stationed at these ports.

PESTS INTERCEPTED

During the year the inspectors and collaborators of the Bureau collected from foreign plants and plant products insects belonging to 1,339 recognized species and others distributed among 1,257 genera and families, fungi and bacteria belonging to 313 recognized species, plant-parasitic nematodes belonging to 8 recognized species, and numbers of interceptions of diseases caused by fungi, bacteria, nematodes, or other agents that could be referred to family, genus, or other group only. Many of these interceptions were of considerable economic or scientific importance.

A total of 86,703 interceptions of insects and plant diseases were made during the year. A summary of the interceptions appears in table 30.

TABLE 30.—*Number of interceptions of insects and plant diseases made during the fiscal year 1937*

Port	Cargo		Stores		Baggage		Quarters		Mail		Total	
	Insects	Diseases	Insects	Diseases	Insects	Diseases	Insects	Diseases	Insects	Diseases	Insects	Diseases
Baltimore	571	60	394	348	3	3	70	21	57	20	1,095	452
Bellingham	12	10	0	0	0	0	0	0	0	0	12	10
Blaine	3	4	0	0	9	7	0	0	0	0	12	11
Boston	111	59	298	280	95	28	36	21	49	25	589	413
Brownsville	3,078	91	10	9	9,011	400	98	0	0	0	12,197	500
Buffalo	36	93	0	3	4	1	0	0	29	6	69	103
Calexico	2	0	0	0	96	2	0	0	0	0	98	2
Charleston	498	6	12	21	0	0	0	1	0	0	510	28
Chicago	6	3	1	1	0	0	1	0	46	8	54	12
Del Rio	0	0	0	0	379	2	0	0	0	0	379	2
Detroit	33	45	7	4	5	2	0	0	21	4	66	55
Douglas	0	16	0	0	13	3	0	0	0	0	13	19
Eagle Pass	520	71	0	0	510	63	0	0	0	0	1,030	134
El Paso	634	82	0	0	796	286	0	0	12	2	1,442	370
Galveston	1,196	4	73	215	1	0	13	3	0	0	1,283	222
Hidalgo	180	15	0	0	1,632	466	0	0	0	0	1,812	481
Honolulu	162	2	20	0	142	7	273	8	147	2	744	19
Houston	30	6	38	980	0	0	7	7	4	1	79	994
Jacksonville [1]	19	8	18	91	5	0	8	3	2	2	52	104
Key West [1]	1	0	1	0	6	0	1	1	0	0	9	1
Laredo	4,017	51	2	0	2,944	63	0	0	10	0	6,973	114
Los Angeles [1]	0	0	0	0	0	0	0	0	30	1	30	1
Mercedes	11	0	0	0	931	51	0	0	0	0	942	51
Miami [1]	229	12	75	32	412	40	169	9	16	7	901	100
Mobile [2]	723	10	115	392	5	5	47	6	0	0	890	413
Naco	3	1	0	0	37	9	0	0	0	0	40	10
New Orleans	4,696	148	153	301	44	11	149	20	19	3	5,061	483
Newport News	13	0	26	147	0	4	0	1	0	0	39	152
New York	5,640	6,993	3,893	1,735	1,671	767	789	121	1,762	162	13,755	9,778
Nogales	4,099	1,566	0	0	716	134	0	0	4	0	4,819	1,700
Norfolk	374	69	202	937	0	2	24	13	0	0	600	1,021
Pensacola [1]	0	0	17	14	1	0	9	0	0	0	27	14
Philadelphia	186	393	305	1,118	12	14	93	88	115	71	711	1,684
Port Arthur	14	0	173	455	1	0	95	5	0	0	283	460
Portland	2	3	8	6	0	0	2	2	3	1	15	12
Presidio	0	0	0	0	49	0	0	0	0	0	49	0
Roma	3	0	0	0	36	12	0	0	0	0	39	12
San Diego [1]	6	0	26	6	0	0	3	0	3	0	38	6
San Francisco [1]	2,309	496	127	19	620	24	196	8	660	210	3,912	751
San Juan	33	8	10	3	36	0	0	0	12	0	91	11
San Pedro [1]	277	1	171	59	147	4	6	0	0	0	601	64
San Ysidro	21	0	0	0	42	6	0	0	0	0	63	6
Savannah	68	0	21	61	0	0	6	3	0	0	95	64
Seattle	464	36	78	28	103	25	72	6	78	25	795	120
Tampa [1]	3	0	14	34	5	6	3	0	0	0	25	40
Washington, D. C.	896	425	0	0	542	110	0	0	1,077	315	2,515	850
Total	31,179	10,781	6,288	7,299	21,061	2,557	2,170	347	4,156	865	64,854	21,849

[1] Collaborators stationed at these ports.
[2] Includes interceptions at Gulfport, Miss.

NOTE.—Inspectors stationed at Puerto Rico made 48 interceptions of insects and 2 interceptions of plant diseases during their field and packing-house inspection of fruits and vegetables for shipment to the mainland.

CERTIFICATION FOR EXPORT

During the year 7,409 certificates, covering 2,780,569 containers of plants and plant products, were issued. This represents a decrease of 1,690 in the number of export certificates issued and of 959,926 in the number of containers certified compared with the figures for the fiscal year 1936. This decrease was largely due to the falling off in the quantities of apples and potatoes exported under certification.

Export certificates were issued at 32 ports, covering 61 different commodities which were exported to 63 foreign countries. Some of the more important commodities inspected and certified were: Apples, 1,945 shipments, consisting of 1,112,194 boxes, 32,278 barrels, and 13,982 baskets; pears, 1,021 shipments, con-

sisting of 633,698 boxes; potatoes, 992 shipments, consisting of 390,139 bags, 12,442 crates, and 9,472 barrels; oranges, 705 shipments, consisting of 328,132 boxes.

Many shipments of apples and pears were certified under a cooperative arrangement with the Bureau of Agricultural Economics of the Department, whereby licensed inspectors of that Bureau located at shipping points make inspections and issue reports which are accepted by the plant quarantine inspector at the port of export as a basis for issuing the required export certificate.

A brief summary of the export certification work appears in table 31.

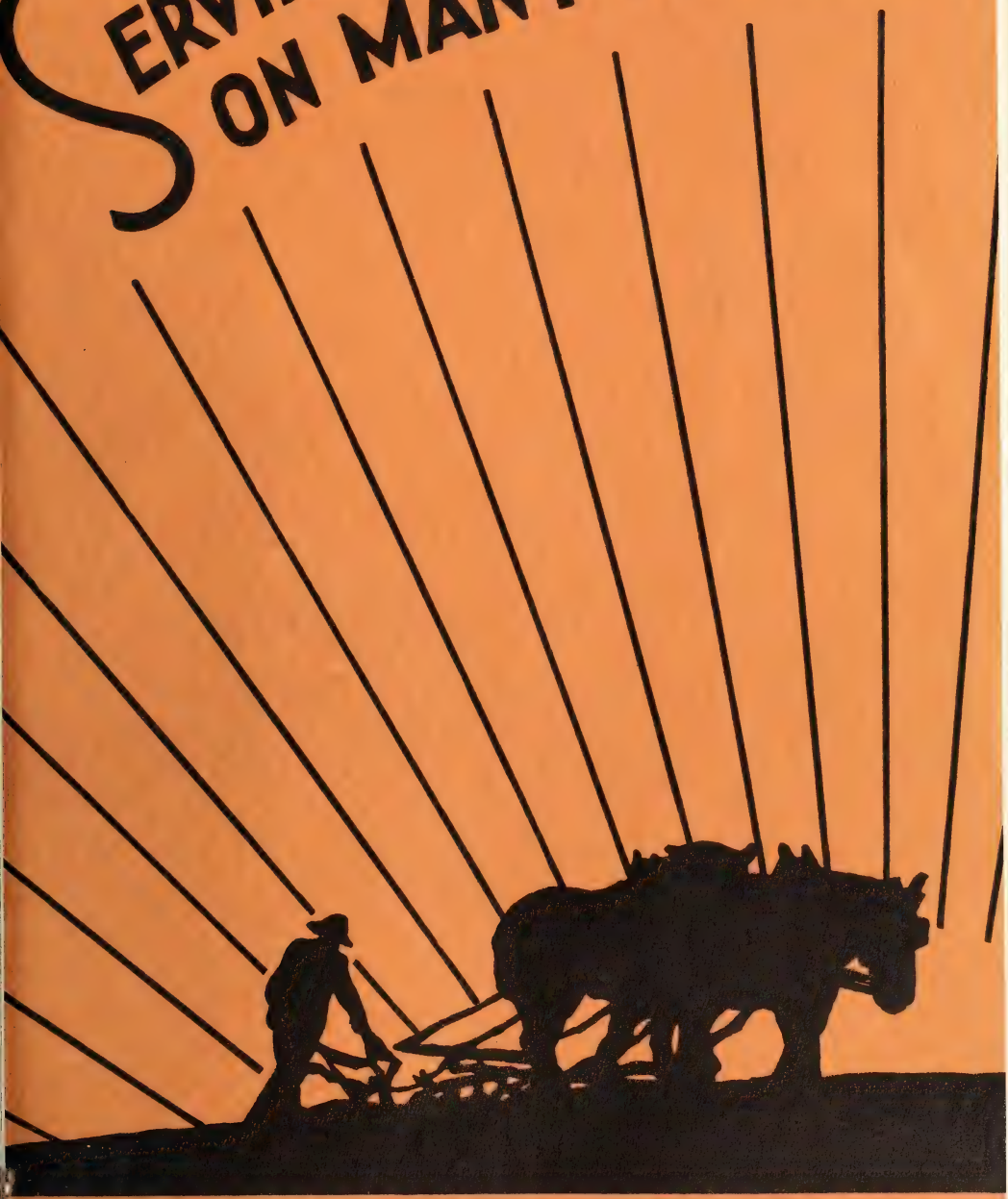
TABLE 31.—*Certification for exportation, by ports, fiscal year 1937*

Ports	Certificates issued	Total containers certified	Commodities certified	Foreign countries	Ports	Certificates issued	Total containers certified	Commodities certified	Foreign countries
	Number	*Number*	*Number*	*Number*		*Number*	*Number*	*Number*	*Number*
Baltimore	35	11,673	3	2	New Orleans	54	3,682	12	4
Boston	1	1	1	1	Newport News	2	47	1	1
Brownsville	18	8,533	3	1	New York	4,007	836,751	42	49
Buffalo	2	470	1	1	Nogales	87	489	7	1
Calexico	26	30,847	5	1	Philadelphia	4	4	1	4
Chicago	2	2	1	2	Port Arthur	2	17,418	1	1
Detroit	37	455	4	4	Portland	698	414,989	8	15
Eagle Pass	1	30	1	1	San Diego	1	2	1	1
El Paso	90	1,140	9	1	San Francisco	223	105,413	12	12
Galveston	5	6	1	1	San Juan	12	61	5	8
Hidalgo	25	270	6	1	San Pedro	596	282,034	4	6
Houston	2	247	2	2	Savannah	1	60	1	1
Jacksonville	5	8,443	3	1	Seattle	1,360	1,040,440	12	12
Laredo	23	12,349	3	1	Tampa	4	21	1	2
Los Angeles	73	3,674	8	3	Washington, D. C.	8	12	1	1
Miami	3	1,000	1	1					
Mobile	2	6	1	2	Total	7,409	2,780,569	------	------

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D.C. - - - - - - Price 15 cents

SERVING FARM PEOPLE ON MANY FRONTS



1937 ANNUAL REPORT OF THE EXTENSION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON, D.C.

For sale by the Superintendent of Documents, Washington, D. C. Price 10 cents

Serving Farm People on Many Fronts

Annual Report of the Extension Service

C. W. Warburton, Director

Reuben Brigham, Assistant Director

CONTENTS

High Lights of Extension Work in 1937

Extension Agents in All Counties of Agricultural Importance

Extension agents in all the counties of agricultural importance in the country during 1937 continued to serve farm people on many fronts, but with added emphasis on applying economics to farming, on agricultural land use planning, and on approaching problems from the standpoint of the whole farm and home.

Extension agents, close to the farm, known in their communities, and with many years of experience behind them, have become the trusted friends and advisers of the farm people they serve. As in the past, they served in 1937 as a far-flung field force carrying information from experiment stations, the State agricultural colleges, the newer action farm programs, and other agencies of the State and Federal Governments to farm people. Operating democratically, understanding local conditions, and close to farm people, extension agents also encounter a steady flow of organized planning and thinking by farm people, which is a guide in forming State and national agricultural policies.

Half Million Unpaid Local Leaders Help

More than a half million farm people, organized, trained, and guided by extension agents, served as unpaid local leaders in their communities during the year. They helped train and develop the more than a million 4–H Club members, helped direct the activities of over 45,000 organized home demonstration clubs with a membership of more than a million rural women, helped develop land use plans for their communities, and helped lead in other farmer cooperative and other educational endeavors. Extension agents held 100,000 training meetings for these local leaders during the year. This building of rural leadership and development of an informed spirit of unselfish community service is a high light of extension accomplishment that is almost immeasurable.

Five Million Rural Families Definitely Influenced

No one accomplishment can be cited as an example to indicate the great variety of sound advice and help that extension agents gave the farm people they served. Reports from the agents, however, show that during the year more than 4,000,000 farm families and 700,000 other families were definitely influenced to adopt at least one or more improved farm and home practices. That represents nearly two-thirds of all the farm families in the country.

These improvements, together with the fact that total attendance at educational meetings held by extension agents during the year was 39,052,454, offer one means of showing the far-flung influence of the network of trained agricultural and home-making leaders that has been built up over the country during the last quarter century. Other and more specific accomplishments and the methods by which they were attained will be found in the following sections of this report.

Changing Problems Demand Changing Approach

Close to the farm as they are, extension agents could not go through the recent period of distressing new farm problems without changing and adapting their methods to help farm people meet these newer challenges.

To that extent, extension work during the year was in a period of transition. Major emphasis of extension agents continued to shift to helping farm people in the broader fields of agricultural planning, and assisting them on their farms and in their homes to make the adjustments necessary to cope with the growing economic and social problems facing them.

Loss of foreign markets, surplus crops, low farm prices, depleted soils, increased farm tenantry, are all conditions that have brought on new problems for county extension agents. Many of the old problems farm people have faced for years have taken on new angles. While farm people have greater need now than ever for the latest sound technical advice, extension agents are finding a real need and opportunity to help in these broader fields.

Helping on New Frontiers

There was a time when extension agents were concerned mostly in perfecting the demonstration method of teaching farm people, and in helping them to adopt the latest technical farm and home practices. New frontiers on which extension agents during recent years, and especially in 1937, helped farm people directly and in cooperation with other agencies include national large-scale community land-use planning, agricultural adjustment, new emphasis on soil conservation, farm security, rural electrification, and farm credit.

2,200 County Planning Committees Functioning

County extension agents during the year organized 2,200 county agricultural program-planning committees, composed of leading farm people, to study conditions in the different communities and work out long-time agricultural programs.

Nearly half of these committees started making land-use maps of their counties showing the long-time adjustments that need to be made in each community.

For many years extension agents have been helping farm people work out community and county-wide improvement programs involving needed adjustments and changes in farming and homemaking practices. Need for widespread adjustments in recent years has caused them to broaden and put far more emphasis on this type of service.

The Extension Service is placing major emphasis on land-use planning and program building not only to help farmers work out locally sound land-use plans for the different communities, but also as a practical means of stimulating and helping farm people on a large scale to study and understand the many local, State, and national problems facing them as well as some of the possibilities of meeting these problems. Such program planning is proving to be one of the agent's best ways of developing understanding farm leadership.

Economic Problems Get More Attention

Extension agents report that during 1937 they spent about 22 percent of their time in what is commonly called agricultural economics and program-planning work. Those same activities took about 13 percent of the agents' time during 1933. Agricultural economic activities took about 4 or 5 percent of the agents' time during 1929 and the 5 preceding years.

At nearly 8,000 meetings during the year extension agents explained different phases of the farm outlook to groups of farm people. These meetings extended to hundreds of thousands of farmers the latest market prospects for the coming year for the crops and livestock and other products they grow. Throughout the year the agents further explained these facts in their close work with farmers as well as helped the program-planning committees to properly and clearly evaluate them.

County agricultural agents during the year encouraged and helped 204,000 farmers to keep records of their farming operations. They helped the farmers summarize and analyze these records, which, in thousands of cases, indicated unprofitable enterprises and put the farm business on a sounder foundation.

These farm records together with the outlook facts and other economic information furnished by the county agents, influenced 350,000 farmers to make at least one important change in management of their farms to put them on a sounder, more profitable business basis.

There were 860,000 members in the 6,600 cooperative marketing groups extension agents assisted during the year. They sold cooperatively 336 million dollars worth of produce compared with 316 million dollars worth in 1936 and 213 million dollars worth in 1929. Reports from the agents show that they also helped 292,000 farmers not in associations with standardization and marketing problems.

Emphasis on Whole Farm and Home Approach

The economic and social nature of such new problems as surplus crops and low prices and widespread farm distress have made it more important in recent years than ever that the 1,500 State extension specialists who help the county agents with specialized problems coordinate their efforts to the fullest.

Reports from the specialists show that in almost every State extension workers placed greater emphasis on closer coordination of all specialized efforts to help farm people. Need for major adjustments in farming and more emphasis on broad long-time program planning for whole communities and counties has caused extension specialists generally to reconsider their specialized programs of service in broader terms of what each can contribute to helping farm people make adjustments and plan whole-farm-approach programs that involve all phases of management of the farm and the farm home.

These increased whole-farm-approach efforts took different form in different States because of varying problems and local conditions. For example, Arkansas extension workers started what they call "double-barreled demonstrations," which simply means the welding

together of numerous old single-phase and single-enterprise demonstrations into whole farm plans for the different communities. Texas workers set out to establish at least three whole farm and home demonstrations in every county in the State. The Ohio Extension Service employed a full-time worker to coordinate the work of all extension specialists and bring about more careful planning of extension programs in counties.

In Minnesota, special project committees were appointed to help with each specific problem. Each of these committees was composed of the several specialists who could help with specific angles of the problem. About three of these special committees held meetings with the extension agents in every county in the State during the year. The meetings usually followed the meetings of the county program-planning committee, composed of farm people, so as best to aid in carrying out the recommendations of the planning committee.

In many States specialists put greater emphasis on correlated State-wide programs for specific enterprises and purposes. The way in which California extension specialists stressed a safe and convenient milk supply for every family and the attractive and proper use of milk in the diet serves as a good example. One of the important goals of the program was to get California rural people to drink an adequate amount of wholesome milk.

Plans to reach this goal were developed jointly by specialists in dairying, farm management, home management, agricultural engineering, veterinary science, farm crops and pastures, and others, along with the nutrition specialist. State boards and producers' associations also cooperated. Not only did each contribute to developing the program, but each assumed definite responsibility for specific parts of it. Led by the specialists, county and home demonstration agents are attacking this task on a whole-family basis.

Agents Spend One-Fourth of Time Explaining A. A. A. Programs

The county agents report that they spent about one-fourth of their time in 1937 explaining and furthering the agricultural conservation program of the Agricultural Adjustment Administration. Stressing soil conservation, the 1937 A. A. A. program dovetailed into the regular Extension Service program and helped thousands of farmers put into effect many of the practices extension agents have been recommending for years.

Though the agricultural conservation program was launched in March 1936, details of the plan were not fully understood in many cases until after the planting season. Extension agents, therefore, found need for much educational work to explain to farmers the revised program for 1937.

Usually the first step in explaining some new major development in the A. A. A. program was for workers in the State extension office and A. A. A. officials to explain the new development to county agents and a few leading county A. A. A. committeemen at State or district meetings. Series of county and community meetings then followed at which the provisions of the program were explained to farmers in terms of how they affected them locally.

10,000 Communities Start New Approach to Soil Conservation

Cover crops, crop rotations, best use of legumes, fertilizers, and manures, and other soil conservation practices have been foremost in Extension Service recommendations for years. Increased national interest in soil and water conservation in recent years has given farmers new agencies and new methods and new types of assistance to help them keep their soils in place and make the best use of them.

County extension agents have not only cooperated with such new agencies as the Soil Conservation Service, Agricultural Adjustment Administration, and Farm Security Administration to help farmers save their soils, but they have continued to carry forward their established soil conservation efforts and with the same whole-farm approach that characterized extension work during the year.

The agents' reports show that they encouraged and helped farmers in 10,000 communities carry forward with greater emphasis a new approach to soil and water conservation. In Illinois, for example, one of the major efforts during the year was to correlate the work of the entire Extension Service into a coordinated soil conservation program for the State. Leaders in this correlated program were the extension specialists in agricultural economics, agricultural engineering, crops, forestry, and soils. Together, and with other extension workers, they worked out a whole-farm-approach soil conservation program for the State, and each assumed leadership of specific parts in it. With county agents, they then held 3-day schools for leading farmers who were acting as local leaders in the various communities, and different specialists explained different phases of the soil conservation problem in that area. These schools were held during the year in 81 counties in the State, with a total local leader attendance of 5,465.

The local erosion-control proving ground and demonstration areas the Soil Conservation Service is operating in each of the major erosion-control problem areas over the country are giving county agents a wealth of new facts with which to help farmers far and wide to check erosion and practice soil and water conservation. The agents are further helping by organizing cooperative soil conservation associations, doing educational work in helping to organize soil conservation districts, helping in rural zoning and district land-use planning programs, taking hundreds of groups of farmers on tours over the erosion-control projects and in other ways.

156,000 Homes Directly Assisted With Electrification

Cooperating with the Rural Electrification Administration, public utilities, and in the Tennessee Valley with the Tennessee Valley Authority, county agricultural and home demonstration agents during the year definitely assisted 156,000 rural homes with electrification. This compares with 17,000 homes assisted in 1935 and 1,600 in 1933.

In addition to explaining the program of these agencies, extension agents helped farmer groups perfect organization of local rural-electrification cooperative associations and obtain loans and other assistance necessary to get rural current for farm and home use.

County agents further assisted 93,000 farmers in the use of electricity in such labor-saving devices as feed-grinding mills, water

pumps, and the like. Home demonstration agents helped farm families make use of the current to ease the burden of housewives by demonstrating and otherwise assisting housewives in the proper use of electrical appliances in the home.

203,000 Farmers Obtain Credit at Low Cost

Extension agents report that they definitely helped 203,000 farmers obtain needed credit at low cost. Much of this help was through working out with the farmers a sound program of farming for the year, which helped the farmer to show lending agencies that he would be able to repay the money.

In addition to recommending deserving, needy farmers for seed and other crop-production loans, extension agents continued close local cooperation with the Farm Credit Administration. In a large number of counties supervised credit demonstrations were started by the county agents in cooperation with the Farm Credit Administration.

County agents continued to assist the Farm Security Administration in its supervised credit program for underprivileged farmers, and in hundreds of counties the farm and home supervisors of the Farm Security Administration occupied the same or adjoining offices with extension agents.

Stronger Programs for Underprivileged

Few people are closer to and have a better chance to see the growing problems of underprivileged farm people than extension agents. With nearly half the farmers in the United States not owning their farms, with countless other farms heavily mortgaged, and with large numbers of farmers in distress, extension agents are pushing stronger programs to help these underprivileged families.

Extension agents have been the chief advocates of self-sustaining, live-at-home farming, and they have led thousands of farmers who could profitably do so, to adjust their farming so as to produce more of the food and other needs of the family on the farm. County and home demonstration agents, for example, report that during 1937 they encouraged thousands to plant more adequate gardens, in addition to specifically helping 323,000 farm families save their home gardens from insects.

Adequate low-cost meals, inexpensive home improvements, and small home industries to produce extra cash have been special projects for families with little cash. Many of the demonstrations and recommendations of extension agents specifically apply to tenant families, and thousands of other farmers following extension recommendations have improved their methods of farming and have been able to pay off or reduce the farm mortgage and hold their farms.

Farm tenants make up a large share of the people helped by extension agents. In Arkansas, for example, a study shows that nearly half of those receiving advice and help from extension agents during the year were from tenant families. The study also showed that during the year 4,775 tenant farmers following better farming recommendations of extension agents were able to buy farms of their own.

Arkansas extension agents are also stressing improved rental and lease agreements between tenants and landlords, and helped 21,225

126445—39——2

tenant farmers enter into the improved agreements. About 24,000 of the 49,000 boys and girls in 4–H Club work in the State and more than half the farm women in home demonstration clubs over the State were from tenant homes.

Oklahoma extension workers began an extensive survey of the tenant situation in that State. Along with the survey extension agents in 20 counties held "feel out" meetings of tenants and landlords looking toward holding a State-wide meeting and a broader effort to improve leases, rental agreements, and the like.

South Carolina home demonstration workers put added stress on plantation demonstrations to show the value to plantation workers of having their sharecroppers make and carry out home-food and feed-supply programs contributing to better health and conserving cash. Extension agents generally in cooperation with health authorities placed added emphasis on sponsoring and helping to hold health clinics, on human disease prevention, on school lunches, on diets to prevent tooth decay, and on helping solve other problems that hit low-income farm families hardest.

Old Problems Have New Angles

Not only have the distressing economic and social problems of recent years brought new frontiers on which extension agents have been helping farm people, but old problems that farm people have been facing for years have taken on new angles.

Nearly a Million Demonstrations Show Better Practices

Extension agents conducted nearly a million adult result demonstrations in cooperation with leading farm people who were willing to help introduce some new practice in their communities. In meetings and field tours to these demonstrations and in community talk among farm people about the results of the new practices, hundreds of thousands of farmers were led to adopt similar practices.

Changing problems in recent years have caused extension agents to change many of these demonstrations to make them better meet the new problems facing farmers. The number of demonstrations with legumes and forage crops has increased 75 percent during the last 3 years. During the same time the number of forestry demonstrations has tripled, and the number of terracing and other agricultural engineering demonstrations has doubled.

Half Million Farmers Follow Crop-Rotation Recommendations

For years extension agents everywhere have urged farmers to adopt improved, locally adapted systems of crop rotations to increase farm income as well as conserve and improve the soil. During 1937 nearly half a million farmers on more than 37 million acres followed the improved crop rotations that extension agents were recommending and demonstrating. By taking advantage of adjustments local farmers needed to make in their farming and of the latest proven soil conservation practices, extension agents were able to make these demonstrations even more practical and helpful than in the past.

Forage Crops Find New Place in Farming

More and more grass and legumes and other forage crops loom large in the modern picture of agricultural adjustment, soil conservation, and economical production of livestock and livestock products. But, back of every adjustment farmers make to promote greater use of both old and new forage crops in their farming plans, must lie an understanding on their part of those crops, their local adaptability, and how best to grow and use them.

In their demonstrations, technical recommendations, and everyday living with farmers, extension agents are helping to give farm people that understanding and to arouse in them an appreciation of the new place of high-quality forage in present-day farming.

This shift to more forage crops brought on by soil conservation and crop-adjustment programs has required farmers to make adjustments in their livestock feeding. County agents have helped thousands of farmers to work out livestock-feeding schedules to make greater use of available roughage, to take advantage of the agricultural conservation program by practicing limited and deferred grazing, and otherwise to adjust their livestock production to changing conditions.

Agents Stress Better Care and Use of Meat

Care and use of meat after it is produced continues to be one of the problems facing farm people today. Extension agents attacked this problem with added emphasis. Assisted by trained State and Federal meat specialists, the agents held training schools about the proper care and use of meat for local leaders on a community basis in 31 States. They stressed cheaper production of quality meat, more meals per carcass, and safer methods of curing more palatable meat on the farm.

In the South extension agents have been stressing safe curing of meat in community refrigerated meat-curing plants. During the year about 50 million pounds of farm-dressed meat was economically cured in about 300 such plants. Much progress was also made in furthering community freezer lockers for storage of meats and other farm products, particularly by extension agents in the Corn Belt and Pacific Northwest.

600,000 Cows Tested in Improvement Associations

County agents during the year fostered or assisted more than 1,100 dairy-herd-improvement associations. The 24,000 members in these associations tested and kept records on nearly 600,000 cows.

Average butterfat production of cows in the associations is now 30 pounds per cow more than it was 10 years ago. At prices reported by the association members the increased production boosted their annual net income about $8,000,000. The herd-improvement records also make it possible for the association members to pick superior strains of cattle and develop outstanding herds from which they can supply improved breeding stock to other farmers.

County agents further used the records of the herd-improvement association members as continuing demonstrations of sound dairy practices. They assisted thousands of farmers not in associations with herd improvement and other dairy problems.

267,000 Farmers Follow Poultry Recommendations

Extension agents in recent years have had to reconsider many of their poultry recommendations and adjust them in terms of the farm needs and adjustments. Scientific production of chicks, good management of layers, and the need for flock improvement to get higher average egg production at lower feed cost, however, are just as important and sometimes more important problems than ever.

Reports from county extension agents show that about 267,000 poultry raisers followed extension chick-raising recommendations. Similar large numbers of poultrymen and farm flock owners participated in "grow healthy chick" programs, pullorum disease eradication drives, and better feeding and flock-improvement programs.

Cost of Crops Cut by Disease Control

With crop diseases costing farmers millions of dollars and sometimes bringing ruin and despair for them, extension agents did much to spread the use of disease-resistant varieties of crops and to pass on and demonstrate to farmers the latest proven methods of control.

County agents helped 187,000 farmers save their wheat crop from smut and rust and other diseases. In Oregon, for example, extension agents encouraged and helped farmers to double the acreage of smut-resistant wheat, and after several years of stressing smut-resistant varieties in Minnesota, 75 percent of the wheat planted in 1937 was of those varieties.

Seed treatment to prevent cotton diseases was stressed throughout the South. In North Carolina, for example, 200,000 acres were planted with treated seed which seed netted farmers a profit of $11 per acre more than regular untreated seed. Extension agents in South Carolina reported that farmers in that State were $1,500,000 better off for having treated their seed to prevent loss from diseases.

Extension agents also carried to farmers latest tested methods of control of blue mold of tobacco plants and many other diseases of crops and fruits and vegetables.

Farmers Follow Insect-Control Recommendations

Reports from extension agents show that thousands of farm people followed specific recommendations by the agents for controlling insects affecting their crops, livestock, and household. The agents assisted farmers over the country in fighting more than 500 different important insects.

County agents and extension entomologists in 23 States in 1937 participated in a Federal grasshopper-control campaign to stop threatening armies of grasshoppers. They helped distribute about 80,000 tons of bait to poison the hoppers as well as helped farmers make the best use of that bait.

Entomologists in Texas estimate that every dollar spent for bait in that State saved $100 worth of crops from grasshoppers. Similar reports from Colorado indicate that farmers and ranchers in that State saved $10,000,000 by following insect-control recommendations.

Extension agents also helped to fight a severe outbreak of armyworms, a major attack by cotton boll weevils and flea hoppers, serious

infestations of screwworms and horse bots, as well as continued costly attacks of termites, flies, and fruit and vegetable insects.

Crop-Improvement Associations Active in 31 States

Convinced that good seed are at the bottom of crop improvement and high yields at low costs, extension agents in 31 States continued to work closely with State crop-improvement associations. These associations are composed of leading farmers who cooperate with the Extension Service and experiment stations in growing certified, registered, and otherwise high-class seed for use of other farmers. Recent droughts seriously reduced the supply of high-class seed in some States, but most of these supplies were replenished.

Farmers Reforest 186,000 Acres

Extension agents conducted more than 9,000 farm timber-stand-improvement, fire-control, and other forestry demonstrations, almost twice the number conducted during 1936. Extension agents encouraged and helped farmers reforest 186,000 acres. Much of this land, retired from unprofitable crop production, was put to better use producing a crop of trees which will also rebuild and conserve the soil.

74,000 Farmers Given Latest Weed-Control Methods

Helping farmers control weeds that compete with crops for life-giving moisture and plant food was one of the major activities of extension agronomists and extension agents in most of the Central and Western or semiarid States. Reports from the agents show that they helped at least 74,000 farmers control weeds by use of the latest proven methods. These sound recommendations allowed farmers to avoid much waste of money with improper weed-control remedies and at the same time do a far more effective job of weed control and eradication.

Farmers Save Their Livestock from Disease and Parasites

Helping farmers save their hogs from internal parasites and cholera and other diseases, their cattle from tick fever, screwworms, tuberculosis, and Bang's disease, and their sheep from liver flukes, worms, and the like have long been major activities of county agents. Much of this help they have given individually and much of it in special educational campaigns in cooperation with veterinarians, the Bureau of Animal Industry of the United States Department of Agriculture, and other agencies. One example of how county agents continued this type of work during 1937 is the 101,000 beef cattlemen whom the agents assisted with disease-control recommendations.

500,000 Office Calls from Fruit and Vegetable Growers

Extension agents conducted more than 26,000 demonstrations of better practices with fruit and vegetable growers, in addition to 62,000 home-garden demonstrations. Their reports show that the agents

received more than 500,000 office calls from persons seeking information about growing fruits and vegetables.

400 Negro Agents Carry Programs to Negroes

While all extension workers help in many ways to extend better farming and homemaking practices to Negroes, 400 Negro county and home demonstration agents, most of them in the South, worked especially with Negroes. They did much the same type of demonstrational and educational work with Negroes that the white agents conducted with white farm people.

Because of the low income of the majority of Negroes, the Negro agents place greater emphasis on helping Negro farmers become self-sustaining. Helping Negro farmers plan for and produce adequate food supplies for their families and otherwise leading them to improve their standard of living with the means they have, were the efforts that received most attention from the Negro agents.

Better Living in Better Homes

Better living in better homes might well be used to sum up the multiplicity of different ways in which county home demonstration agents help farm people attain more satisfying rural life. While carrying on their other programs, home demonstration agents put special emphasis on rural electrification, better housing, consumer education, and on the closest cooperation with relief agencies, the Farm Security Administration, health authorities, and other agencies working with the underprivileged and with pressing social problems.

More Than a Million Women in Home Demonstration Clubs

During 1937 membership in organized county home demonstration clubs climbed to more than a million rural women. There were 45,957 clubs. Under the leadership of home demonstration agents and selected local leaders, trained by specialists and the agents, the women in these clubs were undertaking many phases of better homemaking and community improvement.

The membership in 1937 showed an increase of 66,000 over the preceding year and part of a steady increase of 300,000 members during the preceding 5 years. Home demonstration work has therefore grown into a vast movement of farm women organized to do something for themselves and their communities.

Farm Folks Can $18,000,000 Worth of Produce

The droughts of 1934 and 1936 helped farm people to realize the value of canning and otherwise saving surplus food supplies in the home. "Can a cow," "Live at home," "Plan, plant, preserve, and prosper," and "Conserve and preserve" were slogans of extension agents in many States during 1937. Farm women and club girls cooperating with extension agents canned and otherwise preserved 62,000,000 quarts of fruits, vegetables, and meats and also filled more

than 16,000,000 other containers with jams and jellies. The value of these products was estimated at $18,000,000.

Housewives Follow Wise Buying Recommendations

The fact that farm income during 1937 was nearly 7 percent over 1936 and 25 percent better than in 1935 allowed many families to make long-needed improvements in their homes, replace worn-out equipment, and buy new furnishings and clothing. To help housewives spend this added income wisely, home demonstration programs in all sections of the country put added stress on such phases of their work as conducting consumer institutes, shopping tours, wearing tests on clothing, and projects in wiser buying of clothing, furniture, and food.

These projects and further individual help from the agents led thousands of farm families to spend their income more wisely.

348,000 Families Serve Better Balanced Meals

Better living for the farm family through a planned food supply, home-produced insofar as possible, has been a well-defined goal of extension agents for years. This work, to improve health and reduce cash expenditures, made real progress in 1937.

The nearly 200,000 families that followed a definite well-planned budget of producing and preserving the family food supply was an increase of 8 percent over the previous year. There was also a 35-percent increase in the number of families following home-food-storage recommendations of the Extension Service. Reports from county home demonstration agents show that they helped 348,000 families plan and serve better balanced meals.

Advice Given for Building and Remodeling 19,000 Farm Homes

Extension agents with the help of extension agricultural engineers and home-improvement specialists gave advice and assistance to rural people for building and remodeling more than 19,000 homes—an increase of 50 percent over 1935. They helped 12,000 families install water systems. In 1 year relatively few farm families build new homes or remodel old ones. Many can be interested, however, in improving housing in lesser ways as is shown by the fact that 109,000 families followed extension recommendations in making new home equipment or conveniences to improve their homes.

173,000 Families Assisted To Make Adjustments in Homemaking

Reports from home demonstration agents show that they helped 173,000 families make improvements in their homes and adjustments to improve their systems of homemaking to gain a more satisfactory standard of living. Some of the ways of leading homemakers to make those adjustments were, by helping them to keep and analyze home accounts and to rearrange kitchens and other rooms for greater convenience.

Extension agents helped more than 150,000 families with suggestions about repairing, remodeling, and refinishing furniture. They

assisted 30,000 families in developing home industries as a means of supplementing family income.

Farm Families Save $2,660,000 on Clothing

Though farm women generally had more money to spend for clothing their families in 1937 than during the preceding year, the number enrolled in Extension Service dressmaking and coat-making groups increased. More than 200,000 families took advantage of Extension Service suggestions in remodeling and renovating clothing, and 150,000 families followed buying recommendations. Home demonstration agents estimate farm families saved approximately $2,660,000 on their clothing expenses as a result of the extension clothing program.

107,000 Mothers in Child-Development Program

Home demonstration workers in recent years have placed more and more emphasis on child-development and parent-education problems. A full-time Federal extension specialist was added to the staff to head up and help with this type of work. Home demonstration agents report that 107,000 mothers and a large number of fathers participated in the Extension Service parent-education and child-development program, compared with 92,000 the preceding year and 75,000 in 1935.

Building Rural Citizenship

Despite increasing demands of other activities for the time of extension agents, a steady increase in the enrollment and quality of 4–H Club work over the country continued during 1937.

Forty Percent of Rural Youth Touched by 4–H Clubs

More than 1,192,000 boys and girls were enrolled in 4–H Clubs, which was an increase of 4 percent over 1936, almost 50 percent more than the enrollment in 1930, and more than twice the number enrolled in 1924.

More than a half million new 4–H Club members came into club work during 1937, which was more than 40 percent of the estimated number of rural boys and girls in the United States that annually reach the average 4–H Club starting age of about 12 years. The average period boys and girls remain in 4–H Club work is a little more than 2 years, but many of them remain active club members for 6 or more years.

Boys and Girls Stay in Club Work Longer

The all-time high record of 72 percent of the club members enrolled in 4–H Club work during the year completed the year's work, compared with 69 percent in 1936 and 55 percent in 1924. The 51,000

club members in 1937 that had been in club work 6 years or more was about the same percentage as in 1936 but twice the percentage of active members in club work that long in 1930.

Club Members Carry 1,500,000 Projects

The 1,500,000 projects completed by 4–H Club members in 1937 was 177,000 more than in 1936, and they completed 1.8 percent more of those projects than the percentage completed in 1936. About one-fifth of those projects were definite attempts of the boys and girls to improve their food and nutrition habits. Other projects involved making clothing, home health and sanitation, raising a calf, a colt, a pig, or some chickens, raising a good garden, club leadership, canning, and the like.

Sixteen Percent Increase in Organized Older Young People

In addition to the increase in membership in 4–H Clubs in 1937, extension work with rural young people 16 to 25 years of age who were not in 4–H Clubs increased materially. Nearly 60,000 young farmers and farm women were enrolled in 2,065 young people's clubs during the year. That is an increase of 16 percent in enrollment over the preceding year. Leadership in community recreational, social, and educational undertakings are outstanding activities of these clubs.

The 60,000 enrollment in these older clubs is in addition to the 231,000 boys and girls in regular 4–H Club work that were 16 years or older.

Spreading Information Far and Wide

Mass-Education Methods Supplement Demonstrations

In carrying the latest scientific developments, outlook facts, program explanations, and other information to the masses of farm people, extension agents made much use of newspapers, radio, exhibits, motion pictures, and other mass-education methods to supplement their demonstrations, local meetings, and personal contacts with farm people.

735,000 Educational News Stories

County and home demonstration agents released 735,000 news stories to masses of farm people through local newspapers. Many of these stories were about local demonstrations and meetings; how John Jones did something better, etc. Many of them were based on information passed on to the agents from information workers of the Department of Agriculture in Washington and extension editors in the various States.

126445—39——3

Extension Agents Give 18,000 Radio Talks

County and home demonstration agents and other Extension Service workers made more than 18,000 educational radio talks. This, compared with less than 14,000 the preceding year, less than 12,000 in 1935, and about 4,000 in 1930, shows that the agents are making more and more use of this increasingly important method of disseminating information. Most of these talks were prepared and given locally by the county and home demonstration agents; a number of them were given on regular State and national farm programs.

Twelve Million Farm and Home Bulletins Distributed

Extension workers distributed more than 12 million farm and home bulletins in answer to requests. That is a million more than they distributed during the preceding year and twice the number distributed in 1930.

A majority of those bulletins were prepared by State extension specialists and gave specific facts and recommendations about local rural problems. About 2¼ million of the bulletins distributed were farmers' bulletins, leaflets, and other publications of the United States Department of Agriculture.

Agents Show Farm and Home Exhibits at 33,088 Events

County and home demonstration agents reached additional thousands of people with inspirational and helpful information by preparing small, simple exhibits for 33,088 county fairs and similar events.

In collecting material for and preparing these exhibits, they had the help of State extension specialists and supervisors and editors as well as the Visual Instruction and Editorial Section of the Washington office.

12,000 Department Film Strips Distributed

To help extension agents and other farm leaders visualize their talks about farm and home problems, the Extension Service maintains a film-strip service. About 300 series of pictures in film-strip reels that can be projected on a screen are now available, covering all phases of better farming and homemaking.

Nearly 12,000 of these film strips were distributed to extension agents, other Department of Agriculture field workers, teachers of vocational agriculture, and others. Forty-nine new film-strip series were prepared in cooperation with other Bureaus in the Department, and 43 old strips were revised. Each film strip usually contains from 30 to 50 pictures. The Washington office also cooperated with State extension services in making 17 additional purely local film strips.

Pictures, Posters, Circular Letters Help Tell the Story

The Washington extension office supplied about 20,000 prints of educational farm and home pictures to State and county extension workers, in addition to the large number of pictures taken locally by State offices and county extension agents. About 2,000 new photographs of extension methods and results in the field were added to the

extension photographic library. The library now contains about 50,000 photographs, covering all phases of agriculture and homemaking.

County extension agents prepared about 436,000 different circular letters to farm people to help announce local farm meetings and furnish other helpful information. Many of these letters were illustrated with appropriate interest-getting sketches. About 200 sketches for use of extension agents in illustrating circular letters were prepared in the Washington office, along with 119 drawings and charts for educational mats to newspapers. Posters, charts, and other visual aids helped tell the story of better farming and homemaking.

Seven Million See Department Exhibits at 59 Big Fairs

Department of Agriculture farm and home recommendations reached large numbers of people at the 59 State, interstate, and international fairs and expositions in which the Division of Exhibits of the Extension Service showed exhibits during the fiscal year ended June 30, 1938. About 7 million people saw one or more of these exhibits.

Twenty-five new exhibits were built in cooperation with the different technical units of the Department, 29 others were extensively revised, and 110 were remodeled to make them better tell the story they portrayed.

Department Motion Pictures Viewed by 6 Million People

About 15,000 reels of motion pictures were lent to field extension workers and other educational leaders during the fiscal year ended June 30, 1938, by the Division of Motion Pictures. Reports returned with these reels indicate that about 6 million people saw at least one of these pictures.

In addition to the reels lent, 752 reels of Department motion pictures were purchased by schools and other outside agencies from the Department contractor with Department approval.

The Division of Motion Pictures released 15 new sound motion pictures and 4 new silent pictures, bringing the total number of different motion pictures now in the Department library available for distribution to 283.

Keeping Up With the Times

Studies Show Better Extension Methods

Analysis of reports from extension agents and study of the effectiveness of different methods of extension work furnished extension workers generally suggestions for improving their methods. Sixty-eight briefs were prepared and distributed from previous reports from extension workers analyzing different phases of extension activities and effectiveness of different methods.

Two circulars on extension work in other countries were prepared and distributed, and studies of older-farm-youth problems, local-leader-training methods, influences of 4–H Club work on boys and girls, and similar problems were carried on.

554 Extension Workers Study at Extension Summer Schools

A total of 554 extension workers from 28 different States attended special extension summer schools. The schools, lasting from 3 to 8 weeks, were held at 11 institutions. Extension leaders and specialists from the Federal and various State offices did most of the teaching in the summer schools.

Extension leaders put added emphasis on practical professional training of staff workers as one of the ways for attaining increased efficiency to do the broadening extension job which the relatively small staffs in most States now face.

House Organs Help Staff Keep Up

The Extension Service Review, a 16-page monthly printed house organ, helped staff workers keep up to date. Each issue of the Review was filled with articles from county and home demonstration agents and other extension workers and farm and home leaders pointing out the latest trends and the results of new methods of extension teaching.

The Review contained articles from workers in every State and Territory of the United States. It contained many additional articles prepared in the Washington office especially to help extension agents keep up with the latest trends and developments that affect their work. In addition to the Review, specialists in the Washington office furnished a large amount of technical information to State specialists in circular letters, regular mimeograph releases, and the like.

Eighteen State offices issued similar printed house organs and 12 States put out regular mimeographed house organs in addition to special staff memorandums when needed.

Funds and Personnel

Extension Agents in 2,989 of 3,075 Counties

Extension funds were slightly augmented during the fiscal year ended June 30, 1938, which allowed for a small increase in the number of extension workers. County agents were at work in 2,989 of the Nation's 3,075 counties; assistant agents were employed in many; and home demonstration agents were in 1,862 counties. A total of 1,551 State extension specialists were employed, and the total Extension Service staff included 9,277 workers.

Total Cost of Extension Work $31,000,000—Half Federal Money

Total allotment of funds from all State, Federal, and local sources for the fiscal year ended June 30, 1938, was $31,877,735. About 58 percent of that money, or $18,391,836, was provided by the Federal Government, and the remainder by State and county governments and farm organizations.

Approximately 75 percent of the Federal money spent went for employing county and home demonstration agents, about 18 percent in employing State extension specialists, and the remainder for publications and supervision of the national and State offices.

Final audit and inspection of State extension budgets for the fiscal year 1937 showed a total expenditure of $31,030,281. No appropriated money was withheld from any State for failure to comply with appropriation acts. Total unexpended balance for the year was $237,000, representing small amounts of unused funds in 18 States and 2 Territories.

Looking Ahead

Results of extension work in 1937 clearly show wider fields for service to farm people. Increased emphasis on helping farm people to meet growing economic and social problems, and the large-scale results attained in assisting farmers in planning broad programs point the way to new fields in which county and home demonstration agents can render increasing services. In helping farmers in program planning, extension agents are giving service much more comprehensive than when merely recommending technical practices on individual farms. They have an opportunity to render a service demanded by changing conditions in that they are in position to take the lead in organizing, stimulating, and helping farm people to plan programs and make land use recommendations for entire communities and in terms of their needs as a whole, and of all assistance that different governmental agencies might give farm people to meet those needs.

Appendix

TABLE 1.—*General summary of activities and influence, 1937*

Item	Number	Counties reporting
County associations fostering extension work	6,454	2,569
Members in such associations	915,028	2,495
Number of communities in counties	79,389	2,979
Communities with extension program	60,061	2,757
Voluntary local leaders:		
Men leaders in adult work	209,004	2,621
Women leaders in adult work	198,518	2,434
Men leaders in 4-H club work	32,705	2,574
Women leaders in 4-H club work	56,576	2,636
Older club boy leaders in 4-H club work	14,816	1,619
Older club girl leaders in 4-H club work	21,083	1,724
Clubs or other groups organized to carry on adult home demonstration work	45,957	2,342
Members in such clubs or groups	1,070,273	2,328
Organized 4-H clubs	70,306	2,951
Members in 4-H clubs:		
Enrolled	1,192,385	2,912
Completed	861,958	2,861
4-H club projects:		
Started	2,336,721	2,912
Completed	1,593,329	2,861
Farms in counties with extension agents [1]	6,836,347	3,014
Farms on which changes in practices have definitely resulted from agricultural extension program	3,445,046	2,821
Homes in which changes in practices have definitely resulted from home demonstration program:		
Farm homes	1,238,420	2,302
Other homes	426,466	2,148
Homes with 4-H club members enrolled:		
Farm homes	723,643	2,884
Other homes	178,659	2,473
Families influenced by some phase of the extension program:		
Farm families	4,167,123	2,924
Other families	721,832	2,730

[1] Census, 1935.

TABLE 2.—*Summary of activities by agricultural, home demonstration, and club agents, 1937*

General activities	Total for all lines of work		Reported by home demonstration agents		Reported by club agents [1]		Reported by county agricultural agents	
	Number	Counties reporting	Number	Counties reporting	Number	Counties reporting	Number	Counties reporting
Percentage of time devoted to—								
A. A. A. and relief work	15.05	-------	1.01	-------	2.48	-------	23.00	-------
Regular extension work	84.95	-------	98.99	-------	97.52	-------	77.00	-------
Field work	59.93	-------	64.62	-------	64.49	-------	57.23	-------
Office work	40.07	-------	35.38	-------	35.51	-------	42.77	-------
4-H clubs	70,306	2,951	28,392	1,629	14,442	460	37,920	2,523
Enrollment:								
Boys	503,524	2,912	22,573	349	126,819	460	380,395	2,561
Girls	688,861	2,810	462,042	1,641	89,574	323	201,763	1,592
Completions:								
Boys	361,171	2,861	16,044	328	94,566	460	270,473	2,501
Girls	500,787	2,783	321,671	1,625	71,924	320	134,853	1,598
4-H judging teams trained	36,230	2,082	19,866	798	2,665	344	13,879	1,630
4-H demonstration teams trained	51,453	2,029	28,767	1,102	4,819	326	18,725	1,381
Groups organized for extension work with rural young people above club age	2,065	904	994	458	174	113	1,273	660
Membership	59,637	808	25,590	454	7,179	109	37,090	647
Farm or home visits made	2,857,133	2,980	649,386	1,823	221,119	492	1,993,472	2,945
Different farms or homes visited	1,553,544	2,978	381,426	1,822	119,875	492	1,070,836	2,940
Office calls	18,107,575	2,979	1,079,365	1,802	291,963	454	16,746,011	2,946
Telephone calls	5,979,610	2,924	932,045	1,767	180,502	439	4,869,406	2,884
News articles published	735,773	2,944	228,981	1,807	39,285	454	468,857	2,916
Individual letters written	8,983,693	2,983	1,534,055	1,820	312,443	480	7,137,408	2,947
Different circular letters prepared	436,650	2,972	124,479	1,800	25,700	461	288,180	2,937
Bulletins distributed	12,785,975	2,971	5,103,980	1,806	669,977	455	6,964,690	2,926
Radio talks made	18,497	1,155	5,888	645	997	154	11,609	935
Events at which extension exhibits were shown	33,088	2,670	20,602	1,622	3,351	402	10,683	2,342
Adult leader-training meetings	72,827	2,758	29,254	1,587	563	64	43,529	2,571
Leaders attending	1,370,440	2,538	485,551	1,584	9,000	52	880,112	2,513
4-H leader-training meetings	27,574	2,497	10,638	1,356	2,980	375	15,264	1,851
Leaders attending	449,706	2,496	173,074	1,352	55,029	374	256,284	1,849
Method-demonstration meetings	532,542	2,907	340,240	1,807	29,251	432	165,241	2,780
Attendance	8,930,188	2,905	5,531,630	1,802	489,713	431	2,942,463	2,773
Result-demonstration meetings	95,147	2,387	40,070	1,072	5,497	209	49,939	2,136
Attendance	1,965,136	2,384	766,021	1,070	141,273	208	1,068,099	2,125
Adult tours conducted	9,138	2,156	2,722	792	105	38	6,418	1,950
Attendance	396,368	2,146	113,073	790	4,127	38	286,888	1,963
4-H club tours conducted	8,397	1,818	1,756	515	2,024	349	5,135	1,414
Attendance	249,044	1,814	57,525	511	60,056	348	153,179	1,409
Adult achievement days	8,113	1,825	5,900	1,275	75	22	2,299	835
Attendance	1,298,788	1,815	752,543	1,268	17,965	21	602,932	823
4-H club achievement days	18,792	2,426	7,574	1,392	5,660	372	6,846	1,832
Attendance	2,282,651	2,421	889,793	1,383	412,868	369	1,344,432	1,818
Counties holding farm women's club camps	725	-------	647	-------	2	-------	112	-------
Attendance	64,701	725	55,979	641	81	2	9,974	110
Counties holding 4-H camps	1,967	-------	1,120	-------	317	-------	1,467	-------
Attendance	245,919	1,783	136,708	1,110	35,200	313	112,930	1,429
Total, all meetings held by agents	1,172,590	2,912	544,219	1,807	82,268	444	559,772	2,794
Attendance	39,052,454	2,905	15,531,929	1,802	3,229,156	441	21,422,138	2,788
Adult meetings held by local leaders not participated in by agents	255,540	2,333	139,606	1,386	1,526	36	117,108	1,862
Attendance	4,512,414	2,327	2,167,148	1,380	24,619	34	2,355,405	1,855
4-H Club meetings held by local leaders not participated in by agents	347,895	2,316	118,579	1,243	95,514	331	148,824	1,747
Attendance	5,621,017	2,318	2,529,175	1,240	1,094,411	331	2,786,620	1,744
Meetings held by agents or local leaders at which discussion group method of presentation was followed	151,354	1,812	62,769	856	28,995	192	61,287	1,493

[1] Includes a small amount of work in counties without extension agents, reported by State club leaders.

TABLE 3.—*Summary of activities by projects, 1937*

Project by line of work	Counties reporting work	Days devoted to projects by agents and specialists	Communities in which work was conducted	Voluntary local leaders or committeemen assisting	Adult result demonstrations conducted	Meetings at result demonstrations
Corn	2,484	37,778	28,074	19,647	27,099	4,463
Wheat	1,799	12,674	12,598	8,268	6,325	824
Oats	1,637	7,416	12,139	6,278	6,036	692
Rye	691	2,102	4,922	2,070	2,708	145
Barley	1,070	3,890	6,094	3,076	1,881	287
Other cereals	911	6,032	6,748	3,629	2,792	534
Alfalfa	2,092	17,915	18,159	10,302	10,405	1,308
Sweetclover	1,073	4,793	8,630	4,959	3,496	236
Other clovers	1,347	11,102	12,745	8,305	14,636	1,615
Vetch	890	9,689	10,938	6,408	22,099	1,800
Lespedeza	1,098	10,484	12,834	7,019	23,871	1,650
Pastures	2,372	26,791	24,555	14,070	24,082	3,873
Soybeans	1,495	8,428	12,219	5,416	10,906	843
Cowpeas and field peas	978	6,334	11,372	5,817	19,453	975
Velvetbeans	338	1,489	3,020	1,242	811	143
Field beans	243	1,151	1,362	597	643	123
Peanuts	506	4,650	5,044	2,350	3,468	467
Other legumes and forage crops	1,197	10,781	10,273	5,036	6,921	1,125
Potatoes	1,760	17,495	14,557	7,689	6,933	1,085
Sweetpotatoes	850	6,432	7,523	3,236	4,967	721
Cotton	1,008	46,061	17,740	17,152	45,142	4,599
Tobacco	523	14,090	4,614	3,240	5,903	944
Other special crops	697	9,588	4,181	2,218	2,304	596
Home gardening	2,005	43,886	34,976	28,029	62,051	7,047
Truck crops	1,382	19,196	10,813	5,735	8,958	1,386
Home grounds	1,534	28,836	23,885	20,388	39,891	5,043
Tree fruits	2,020	29,146	16,154	8,063	10,803	1,933
Bush or small fruits	958	6,338	6,886	3,358	4,238	544
Grapes	691	2,973	3,686	1,623	2,326	322
Forestry	1,978	17,726	14,336	8,850	9,031	1,298
Wildlife conservation	780	4,913	3,958	3,971	1,287	170
Agricultural engineering	2,495	80,158	27,967	26,420	30,944	5,970
Poultry	2,814	70,017	39,316	27,115	31,255	6,657
Bees	670	2,745	2,747	988	726	141
Dairy cattle	2,705	72,098	30,199	20,278	12,682	2,024
Beef cattle	2,377	41,479	20,232	11,726	5,743	2,773
Sheep	2,044	23,726	14,279	8,760	3,916	786
Swine	2,553	44,082	24,326	13,211	10,476	2,780
Horses and mules	1,904	13,869	13,980	8,802	4,622	585
Other livestock	472	2,543	2,014	640	321	115
Public problems	2,198	60,934	25,995	36,801	9,831	488
Farm records	2,047	23,434	18,281	8,137	13,798	835
Farm planning	1,614	19,363	13,062	4,723	10,904	604
Farm and home financing	1,624	10,573	13,397	4,090	2,787	156
Outlook	1,581	9,464	14,125	7,885	2,690	117
Marketing	1,836	24,697	17,036	12,460	4,116	1,075
Food selection and preparation	1,699	77,673	35,774	57,597	53,308	4,639
Food preservation	1,496	44,875	28,968	31,088	71,654	7,729
Child development	948	12,756	11,596	14,710	9,987	1,467
Clothing	1,762	102,713	40,533	70,213	57,322	6,978
Home management	1,365	35,391	21,650	31,095	27,946	3,284
House furnishings	1,595	56,957	26,183	35,653	39,568	6,272
Handicraft	839	13,073	13,231	12,750	21,211	1,527
Home health	1,143	19,235	23,194	24,603	20,252	3,094
Extension organization	2,570	228,276	55,435	150,178	----------	----------
Community activities	1,870	87,134	37,530	88,821	----------	----------
Predatory animals	211	1,404	1,131	573	431	20
Rodents	1,060	5,736	8,976	6,464	8,100	501
General feeder insects	1,705	20,777	17,679	19,909	13,357	2,632
Weeds	1,237	8,828	8,871	14,817	3,717	329
All other work	1,263	63,905	16,218	18,875	4,374	850
Cooperation with—						
Agricultural Conservation and Domestic Allotment	2,842	283,399	51,025	42,457	----------	----------
Soil Conservation Service	1,217	27,105	10,232	8,758	----------	----------
Rural Rehabilitation and Resettlement	1,647	13,441	13,549	5,379	----------	----------
Rural Electrification	1,401	17,371	11,750	19,855	----------	----------
Tennessee Valley Authority	365	20,128	3,412	2,996	----------	----------
Works Progress Administration	469	5,451	3,826	2,260	----------	----------
National Youth Administration	631	6,550	3,986	1,354	----------	----------
Social Security, Public Health Service, Children's Bureau	226	1,758	2,516	1,902	----------	----------
Other agencies	513	6,595	4,830	4,850	----------	----------

TABLE 3.—*Summary of activities by projects, 1937*—Continued

Project or line of work	Method demonstration meetings held	Other meetings held	News stories published	Different circular letters issued	Farm or home visits made	Office calls received
Corn	8,376	8,256	13,429	6,672	83,375	344,461
Wheat	2,083	2,968	6,862	2,761	24,648	263,434
Oats	1,590	1,623	3,220	1,237	14,421	96,619
Rye	294	405	766	397	4,402	39,144
Barley	481	939	3,848	671	7,993	42,254
Other cereals	1,143	1,642	2,664	1,217	11,132	93,977
Alfalfa	1,889	5,286	8,949	4,825	39,799	278,649
Sweetclover	465	1,584	2,787	1,329	7,728	111,303
Other clovers	1,869	3,019	4,088	3,129	27,233	137,821
Vetch	3,190	2,614	2,400	1,801	19,111	145,038
Lespedeza	1,696	2,699	3,281	1,813	24,354	172,818
Pastures	3,763	5,126	9,904	9,400	55,612	253,270
Soybeans	1,763	1,943	3,170	1,433	16,121	122,535
Cowpeas and field peas	1,545	1,464	1,502	1,178	12,006	125,557
Velvetbeans	403	196	225	313	5,776	16,691
Field beans	153	186	303	177	2,957	10,030
Peanuts	1,011	946	801	669	8,506	45,394
Other legumes and forage crops	1,886	2,353	4,165	2,272	21,583	164,195
Potatoes	3,201	4,365	6,284	4,625	41,801	115,274
Sweetpotatoes	2,086	990	1,245	941	12,758	47,091
Cotton	8,232	10,958	10,255	8,997	83,126	1,599,849
Tobacco	2,122	1,931	2,722	1,915	37,461	264,506
Other special crops	917	1,764	1,728	1,043	19,418	80,637
Home gardens	23,440	11,803	14,089	11,762	104,925	177,738
Truck crops	4,004	3,901	6,158	3,853	44,679	104,355
Home grounds	16,868	6,809	11,381	6,150	56,609	85,677
Tree fruits	7,816	4,659	10,247	8,626	72,471	168,221
Bush or small fruits	2,116	1,102	2,196	1,404	12,748	36,807
Grapes	1,220	369	1,054	531	6,307	19,684
Forestry	4,583	4,242	8,113	3,797	27,351	98,474
Wildlife conservation	1,063	2,054	1,938	1,403	6,842	25,054
Agricultural engineering	23,507	13,639	19,511	10,509	154,361	520,227
Poultry	26,442	18,076	27,409	20,075	163,046	403,502
Bees	646	778	1,299	1,251	4,966	13,830
Dairy cattle	12,404	16,686	27,960	17,322	142,540	338,785
Beef cattle	9,322	7,757	14,798	7,677	91,716	248,370
Sheep	6,734	5,523	10,972	7,052	52,946	150,833
Swine	15,667	7,768	11,394	6,671	110,533	296,059
Horses and mules	3,804	3,475	6,037	3,935	31,559	111,019
Other livestock	431	630	921	613	4,831	22,680
Public problems	3,748	29,391	21,351	15,857	40,763	1,490,823
Farm records	3,175	4,105	5,890	7,135	51,405	112,153
Farm planning	1,527	2,654	2,561	2,327	32,622	173,689
Farm and home financing	661	2,692	3,126	1,122	9,416	245,387
Outlook	1,370	6,308	5,686	3,069	7,808	109,665
Marketing	2,908	8,316	10,594	6,573	38,206	267,168
Food selection and preparation	113,399	36,666	39,378	18,343	82,660	138,715
Food preservation	50,104	14,789	15,242	9,087	69,443	140,754
Child development	13,756	6,597	5,304	3,593	15,084	25,108
Clothing	164,325	62,220	41,164	21,603	104,184	180,334
Home management	45,306	13,027	21,614	8,505	43,267	70,237
House furnishings	76,510	17,579	26,407	11,764	71,938	100,758
Handicraft	19,877	6,235	3,704	2,887	17,445	27,434
Home health	23,426	12,150	7,712	3,958	31,737	46,266
Extension organization	----------	133,690	87,950	62,333	208,316	851,159
Community activities	----------	87,268	51,025	33,732	97,624	377,682
Predatory animals	114	163	318	184	1,015	11,939
Rodents	2,011	877	2,708	1,459	11,530	83,133
General feeder insects	4,793	3,176	13,166	5,245	42,581	515,121
Weeds	1,307	2,363	4,861	1,714	19,207	96,700
All other work	9,729	20,050	22,661	14,518	68,056	529,463
Cooperation with—						
Agricultural Conservation and Domestic Allotment	----------	104,087	73,745	90,877	354,439	8,666,260
Soil Conservation Service	----------	8,134	6,917	3,994	55,241	312,305
Rural Rehabilitation and Resettlement	----------	5,295	2,511	1,790	19,367	167,212
Rural Electrification	----------	9,262	8,346	4,397	42,328	207,447
Tennessee Valley Authority	----------	2,494	1,285	2,172	36,033	56,363
Works Progress Administration	----------	4,363	1,501	869	17,953	52,181
National Youth Administration	----------	2,833	826	837	11,902	29,696
Social Security, Public Health Service, Children's Bureau	----------	1,509	393	218	2,136	13,462
Other agencies	----------	2,887	1,146	1,066	7,685	92,323

TABLE 4.—*Summary of results, 1937: Crops*

Project or line of work	Farmers following fertilizer recommendations	Farmers following insect-control recommendations	Farmers following disease-control recommendations	Farmers following marketing recommendations	Farmers assisted in using timely economic information as basis for readjusting enterprise
Corn	313,940	239,129	99,666	71,271	442,185
Wheat	132,539	209,990	187,374	36,503	185,383
Oats	79,576	78,994	162,352	17,388	115,359
Rye	9,197	14,864	6,080	4,029	29,650
Barley	24,848	36,499	47,895	7,374	52,954
Other cereals	8,540	31,658	21,964	8,927	42,980
Alfalfa	129,357	90,141	8,218	13,647	115,768
Sweetclover	22,548	20,518	1,383	4,185	48,416
Other clovers	76,061	10,692	4,514	6,908	67,359
Vetch	62,082	3,162	1,453	4,228	53,978
Lespedeza	37,847	4,823	1,048	7,587	67,579
Pastures	69,573	29,594	2,352	5,909	96,081
Soybeans	31,787	13,910	2,973	13,172	87,648
Cowpeas and field peas	16,905	11,828	3,070	12,008	79,287
Velvetbeans	3,578	696	433	2,854	15,003
Field beans	7,436	6,607	8,898	3,255	8,961
Peanuts	15,142	1,350	1,434	22,951	31,420
Other legumes and forage crops	26,403	8,394	2,725	4,252	46,299
Potatoes	86,647	160,628	92,581	41,594	58,912
Sweetpotatoes	28,969	15,693	31,813	13,628	20,382
Cotton	314,248	152,155	82,053	253,058	503,449
Tobacco	79,908	85,783	45,030	41,095	97,926
Other special crops	25,689	17,359	14,231	11,421	15,752
Home gardens	170,298	323,679	155,990	31,548	98,140
Truck crops	61,640	72,508	50,857	38,884	41,237
Tree fruits	46,474	99,704	87,922	18,298	34,234
Bush and small fruits	17,031	24,187	18,146	10,524	13,002
Grapes	5,543	12,278	12,850	3,287	5,040

TABLE 5.—*Summary of results, 1937: Livestock*

Project or line of work	Dairy cattle	Beef cattle	Sheep	Swine	Horses and mules	Other livestock
Farmers assisted in obtaining purebred sires	15,047	11,849	12,851	15,560	1,614	371
Farmers assisted in obtaining high-grade or purebred females	16,300	7,750	9,100	15,343	4,388	597
Bull, boar, ram, or stallion circles or clubs organized or assisted	664	145	116	276	435	18
Members in such circles or clubs	7,642	1,906	1,382	2,447	7,704	229
Herd-improvement associations organized or assisted	1,809	164	130	144	81	10
Members in such associations	29,613	5,552	7,080	2,152	2,712	209
Farmers not in associations keeping performance records of animals	21,672	3,041	1,444	4,521	708	64
Families assisted in butter and cheese making	27,742	----------	----------	----------	----------	----------
Farmers following parasite-control recommendations	32,923	28,842	86,668	97,922	97,987	2,312
Farmers following disease-control recommendations	308,560	101,165	36,579	176,457	50,631	2,929
Farmers following marketing recommendations	61,582	32,867	39,392	83,181	2,291	430
Farmers assisted in using timely economic information as a basis for readjusting enterprise	114,789	55,426	32,180	112,329	23,734	1,051
Families assisted in home butchering, meat cutting, and curing	----------	15,187	1,724	37,815	----------	----------

TABLE 6.—*Summary of results, 1937: Forestry, engineering, conservation*

Project or line of work	Number or value	Counties reporting
Forestry:		
Farms on which new areas were reforested by planting small trees	44,416	1,281
Acres involved	186,330	1,216
Farmers planting windbreaks or shelterbelts	24,256	843
Farmers planting trees for erosion control	16,217	870
Farmers making improved thinnings and weedings	19,160	855
Farmers practicing selection cutting	20,357	667
Farmers pruning forest trees	12,209	457
Farmers cooperating in prevention of forest fires	164,628	662
Farmers adopting improved practices in production of naval stores	5,318	92
Farmers adopting improved practices in production of maple sugar and sirup	3,776	126
Farmers assisted in timber estimating and appraisal	3,554	382
Farmers following wood-preservation recommendations	13,827	452
Farmers following recommendations in the marketing of forest products	8,446	454
Wildlife		
Farms on which specific improvements on wildlife have been made	11,505	442
4-H Club members engaged in rabbit activity	1,032	134
Rabbits produced by 4-H Club members	5,481	83
Adults engaged in rabbit activity	1,098	73
Rabbits produced by adults	8,275	38
4-H Club members engaged in fox and other fur-animal activities	217	25
Animals produced by 4-H Club members	909	11
Adults engaged in fox and other fur-animal activities	721	71
Animals produced by adults	6,510	41
4-H Club members engaged in game-bird activity	7,102	363
Game birds produced by 4-H Club members	33,026	182
Adults engaged in game-bird activity	9,837	330
Game birds produced by adults	213,374	167
4-H Club members engaged in conservation-camp activity	2,461	364
Adults engaged in conservation-camp activity	1,406	138
Agricultural engineering:		
Farmers following improved drainage practices	18,748	959
Farmers following improved irrigation practices	9,000	556
Farmers following land-clearing practices	15,938	433
Farmers using better types of machines	28,565	811
Farmers following recommendations in the maintenance and repair of machines	57,061	671
Farmers following recommendations in the efficient use of machinery	33,505	463
Farmers constructing buildings according to recommendations	56,943	1,969
Total value of service or savings	$4,843,276	1,283
Farmers having buildings remodeled, repaired, or painted	70,176	1,481
Total value of service or savings	$2,809,203	989
Farmers installing electrification units	156,451	1,048
Total value of service or savings	$3,304,877	564
Homes in which improved equipment was used	85,760	830
Total value of service or savings	$1,174,439	517
Dwellings constructed according to plans furnished	5,255	658
Dwellings remodeled according to plans furnished	14,173	738
Sewage systems installed	7,234	901
Water systems installed	11,895	993
Heating systems installed	4,018	382
Lighting systems installed	74,437	893
Home appliances and machines installed	82,004	682
Dairy buildings erected or remodeled	8,695	1,021
Silos erected	3,604	601
Trench or pit silos constructed	15,357	1,015
Hog houses erected or remodeled	10,263	938
Poultry houses erected or remodeled	25,889	1,770
Storage structures erected or remodeled	13,966	862
Other farm buildings erected or remodeled	20,839	776
Soil conservation:		
Farmers practicing proper land use—based on soil types	94,864	652
Acres involved	10,919,052	614
Farmers using recommended crop rotations	469,312	1,575
Acres involved	37,192,070	1,465
Farmers practicing strip cropping	43,565	869
Acres involved	2,321,626	828
Farmers using cover crops	536,854	1,509
Acres involved	12,497,459	1,443
Farmers testing for soil acidity	174,688	1,411
Acres involved	4,057,954	1,199
Farmers applying lime materials	323,378	1,484
Tons involved	5,635,621	1,416
Farmers applying recommended fertilizers	433,221	1,591
Tons involved	2,819,153	1,506
Farmers practicing approved summer fallowing	180,736	764
Acres involved	8,805,924	728
Farmers constructing terraces	76,255	1,182
Acres involved	2,183,063	1,126

TABLE 6.—*Summary of results, 1937: Forestry, engineering, conservation*—Con.

Project or line of work	Number or value	Counties reporting
Soil conservation—Continued.		
Farmers growing crops on contour	142, 538	961
Acres involved	6, 649, 899	921
Farmers grassing waterways	21, 256	520
Acres involved	501, 652	472
Farmers practicing pasture and range improvement by contouring	16, 115	686
Acres involved	2, 027, 427	667

TABLE 7.—*Summary of results, 1937: Agricultural economics*

Project or line of work	Number or value	Counties reporting
Marketing:		
Marketing associations or groups assisted in organizing during the year	1, 090	683
Marketing associations previously organized	5, 637	1, 666
Membership in associations and groups organized or assisted	860, 239	1, 609
Individuals (not in associations) assisted with marketing problems	292, 138	1, 823
Organizations assisted with problems of standardizing, packaging, or grading	1, 491	757
Organizations assisted with problems of processing or manufacturing	559	263
Organizations assisted with problems of locating markets and transportation	1, 562	790
Organizations assisted with problems of use of current market information	2, 389	849
Organizations assisted with problems of financing	1, 141	637
Organizations assisted with problems of organization	1, 853	912
Organizations assisted with problems of accounting	922	474
Organizations assisted with problems of keeping membership informed	3, 162	1, 229
Individuals (not in organizations) assisted with problems of standardizing, packaging, or grading	46, 491	721
Individuals (not in organizations) assisted with problems of processing or manufacturing	12, 451	247
Individuals (not in organizations) assisted with problems of locating markets and transportation	73, 054	963
Individuals (not in organizations) assisted with problems of use of current market information	140, 918	996
Products sold by all associations or groups organized or assisted	$336, 395, 378	527
Products sold by individuals (not in organizations) assisted	$87, 469, 259	616
Supplies purchased by all associations or groups organized or assisted	$58, 902, 264	651
Supplies purchased by individuals (not in organizations) assisted	$15, 220, 941	573
Farm records:		
Farmers keeping regular farm accounts throughout the year	49, 557	1, 720
Farmers keeping A. A. A. farm accounts throughout the year	170, 331	879
Farmers keeping cost-of-production records	45, 579	1, 169
Farmers assisted in summarizing and interpreting their accounts	52, 900	1, 581
Farmers assisted in making inventory or credit statements	51, 789	1, 369
Farm business or enterprise-survey records taken	22, 564	390
Individual farm planning:		
Farmers making recommended changes in their business as result of keeping accounts or survey records	46, 216	1, 206
Other farmers adopting cropping, livestock, or complete farming systems according to recommendations	313, 892	1, 494
Farmers advised relative to leases	67, 074	1, 741
Farmers assisted in developing supplemental sources of income	109, 776	1, 343
Families assisted in reducing cash expenditure by exchange of labor or machinery	24, 980	551
Families assisted in reducing cash expenditure by bartering farm or home products for other commodities or services	52, 422	614
Families assisted in reducing cash expenditure by producing larger part of food on farm	351, 726	1, 206
Families assisted in reducing cash expenditure by making own repairs of buildings and machinery	64, 814	873
Urban families assisted in getting established on farms	14, 073	1, 078
Farm families on relief assisted to become self-supporting	33, 156	917
Farm and home financing:		
Farmers assisted in obtaining credit	203, 812	2, 218
Farmers assisted in making mortgage or other debt adjustments	26, 169	1, 278
Farm credit associations assisted in organizing	242	166

TABLE 8.—*Summary of results, 1937: Home economics*

Project or line of work	Number or value	Counties reporting
Food preservation:		
Families budgeting food expenditures for year	72, 138	1, 006
Families following food-buying recommendations	144, 113	1, 135
Families serving better-balanced meals	348, 719	1, 685
Families improving home-packed lunches	158, 888	1, 148
Schools in which recommendations for a hot dish or school lunch were followed	10, 868	865
Children involved	549, 574	799
Families following recommended methods of child feeding	91, 098	995
Individuals adopting recommendations for corrective feeding	102, 658	919
Families producing and preserving home food supply according to annual food-supply budget	197, 659	1, 320
Families assisted in canning or otherwise preserving of fruits, vegetables, and meats	513, 024	1, 804
Quarts canned—		
By adults	62, 388, 132	1, 623
By juniors	6, 930, 092	1, 740
Other containers of jam, jelly, or other products made—		
By adults	16, 076, 339	1, 428
By juniors	1, 289, 016	1, 457
Estimated value of all products canned or otherwise preserved	$18, 746, 358	1, 698
Families following recommendations for the storage of home food supply	195, 448	1, 432
Families assisted in using timely economic information as a basis for readjusting family food supply	249, 527	1, 171
Child development and parent education:		
4-H Club members not in special child-development projects who participated in definite child-development work	14, 696	200
Families improving habits of children	67, 227	712
Families substituting positive methods of discipline for negative ones	30, 433	543
Families providing recommended play equipment	28, 296	618
Families following recommendations regarding furnishings adapted to children's needs	19, 559	551
Different men participating in child-development and parent-education program	15, 311	201
Different women participating in child-development and parent-education program	107, 328	678
Children involved	218, 222	626
Clothing:		
Individuals following recommendations in construction of clothing—		
Adults	285, 586	1, 537
Juniors	279, 645	1, 779
Individuals following recommendations in the selection of clothing—		
Adults	245, 726	1, 413
Juniors	204, 635	1, 586
Individuals keeping clothing accounts—		
Adults	38, 541	904
Juniors	71, 059	1, 125
Individuals budgeting clothing expenditures—		
Adults	32, 948	763
Juniors	30, 703	671
Families following clothing buying recommendations	152, 339	1, 184
Individuals improving children's clothing—		
Adults	101, 580	1, 029
Juniors	29, 464	570
Individuals following recommendations in improving care, renovation, and remodeling of clothing—		
Adults	213, 359	1, 317
Juniors	82, 537	945
Families assisted in using timely economic information in determining how best to meet clothing requirements	142, 158	866
Estimated savings due to clothing program—		
Adults	$1, 975, 184	1, 219
Juniors	$685, 740	1, 320
Home management:		
Kitchens rearranged or improved for convenience	93, 631	1, 313
Families following recommendations in obtaining labor-saving equipment	93, 588	1, 209
Families adopting recommended laundering methods	63, 008	844
Families assisted in making soap	52, 024	695
Families adopting recommended methods in care of home	138, 994	999
Families assisted in making equipment or conveniences	108, 996	1, 231
Women following a recommended schedule for home activities	51, 463	732
4-H Club members keeping personal accounts	30, 999	751
Families keeping home accounts according to a recommended plan	32, 421	1, 127
Families budgeting expenditures in relation to income according to a recommended plan	22, 584	674
Families assisted in developing home industries as a means of supplementing income	30, 671	667
Families following recommended methods in buying for the home	91, 684	962
Families assisted in using timely economic information as a basis for readjusting family living	76, 118	744

TABLE 8.—*Summary of results, 1937: Home economics*—Continued

Project or line of work	Number or value	Counties reporting
Home management—Continued.		
Families assisted in making adjustment in homemaking to gain a more satisfactory standard of living	172,958	1,031
Families having increased time for rest and leisure activities as a result of the home-management program	73,311	698
House furnishings:		
Families improving the selection of household furnishings	162,815	1,321
Families following recommendations in improving methods of repairing, remodeling, or refinishing furniture	150,278	1,444
Families following recommendations in improving treatment of windows	125,120	1,298
Families following recommendations in improving arrangement of rooms	140,974	1,341
Families improving treatment of walls, woodwork, and floors	133,769	1,319
Families applying principles of color and design in improving appearance of rooms	142,858	1,357
Total estimated savings due to house-furnishing program	$1,704,543	1,061
Handicraft:		
Families following recommendations regarding handicraft	110,137	842
Home health and sanitation:		
4-H Club members having health examination or recommendation of extension workers or participating in health contests	122,441	1,084
Number of individuals other than 4-H Club members having health examination on recommendation of extension workers or participating in health contests	62,428	459
4-H Club members not in special health projects who participated in definite health-improvement work—		
Boys	36,922	430
Girls	133,510	816
Individuals improving health habits	244,398	1,191
Individuals improving posture	142,300	1,088
Individuals adopting recommended positive preventive measures to improve health	302,565	711
Families adopting better home-nursing procedure	53,521	613
Families installing sanitary closets or outhouses	57,199	822
Houses screened	66,431	755
Families following other recommended methods of controlling flies, mosquitoes, and other insects	93,671	780
Individuals enjoying improved health as a result of health and sanitation program	309,165	723
Community or country-life activities:		
Communities assisted in making social or country-life surveys, or in scoring themselves or their community organizations	5,494	390
Country-life conferences or training meetings conducted for community leaders	4,760	697
Community groups assisted with problems of organization or programs of activities, or meetings	30,797	1,516
Communities developing recreation	16,574	1,209
Families following recommendations as to home recreation	93,996	816
Community or county-wide pageants or plays presented	7,802	932
Community houses, clubhouses, permanent camps, or community rest rooms established for adults	777	363
Community houses, clubhouses, permanent camps, or community rest rooms established for juniors	359	216
Communities assisted in establishing work centers for such activities as canning, seed treatment, and meat curing	1,865	361
Communities assisted in improving hygienic or public-welfare practices	6,399	486
School or other community grounds improved in accordance with plans furnished	4,690	774
Communities assisted in providing library facilities	4,142	603
4-H Clubs engaging in community activities, such as improving school grounds and conducting local fairs	14,941	1,236
Families aided in obtaining assistance from Red Cross or other relief agency	61,622	749

TABLE 9.—*Summary of results, 1937: Poultry and miscellaneous*

Project or line of work	Number or value	Counties reporting
Poultry:		
Families following an organized improved breeding plan as recommended	72,061	1,722
Families following recommendations in purchasing baby chicks	173,704	2,206
Families following recommendations in chick rearing	267,140	2,350
Families following production-feeding recommendations	261,224	2,399
Families following sanitation recommendations in disease and parasite control	253,493	2,488
Families improving poultry-house equipment according to recommendations	83,119	2,339
Families following marketing recommendations	119,192	1,560
Families assisted in using timely economic information as a basis for readjusting enterprise	140,929	1,440
Bees:		
Farmers following recommendations in transferring colonies to modern hives	3,460	450
Colonies involved	27,733	425
Farmers following disease-control recommendations	10,563	451
Farmers following requeening recommendations	3,026	369
Farmers following marketing recommendations	2,050	211
Predatory animals:		
Farmers following recommendations	5,529	132
Estimated savings due to control program	$354,800	97
Rodents:		
Farmers following recommendations	125,831	863
Pounds of poison bait used	5,574,978	734
Estimated savings due to control program	$4,151,368	642
General feeder insects:		
Farmers following recommendations	447,007	1,271
Pounds of poison bait used	146,259,117	1,155
Estimated savings due to control program	$59,746,845	1,011
Weeds:		
Farmers following recommendations	74,537	814
Pounds of poison used	4,869,655	493
Estimated savings due to control programs	$1,851,144	433
Cooperation with other agencies:		
Farms or homes directly assisted by extension agents to carry out program of—		
Agricultural Adjustment Administration	2,142,580	2,234
Soil Conservation Service	99,925	694
Farm Security Administration	63,619	1,009
Rural Electrification Administration	172,299	745
Tennessee Valley Authority	17,992	258
Works Progress Administration	28,447	292
National Youth Administration	11,063	426
Social Security Board, Public Health Service, and Children's Bureau	10,947	155
Other agencies	44,306	282

TABLE 10.—*Summary of results with boys' and girls' projects,*[1] *1937*

Project	Boys enrolled	Girls enrolled	Boys completing	Girls completing	Units involved in club work	Quantity produced
	Number	*Number*	*Number*	*Number*	*Acres*	
Corn	79,697	1,628	56,371	1,266	109,161	3,695,994 bushels.
Wheat	2,908	32	2,145	21	17,602	342,971 bushels.
Oats	1,411	11	1,015	10	5,866	133,156 bushels.
Rye	91	----------	51	----------	78	1,249 bushels.
Barley	719	5	532	3	2,244	55,766 bushels.
Other cereals	4,925	110	3,711	88	12,724	
Alfalfa	561	7	396	6	950	613 bushels. 2,328 tons.
Sweetclover	34	4	23	4	38	15 bushels. 33 tons.
Other clovers	951	----------	623	----------	316	1,793 bushels. 60 tons.
Vetch	765	----------	333	----------	415	2,407 bushels. 143 tons.
Lespedeza	427	5	204	3	326	677 bushels. 299 tons.
Pastures	604	14	333	7	2,689	
Soybeans	2,475	10	1,540	8	2,188	18,379 bushels. 3,166 tons.
Cowpeas	1,927	73	1,485	65	2,023	13,320 bushels. 1,158 tons.
Velvetbeans	220	2	185	1	222	1,542 bushels. 83 tons.
Field beans	807	54	653	28	784	9,971 bushels. 335 tons.
Peanuts	10,528	476	6,458	291	5,609	3,245,780 pounds. 3,637 tons.
Other legumes	1,162	23	739	19	1,212	
Potatoes	23,668	2,434	17,475	1,820	9,232	868,629 bushels.
Sweetpotatoes	7,535	543	5,164	435	3,268	363,904 bushels.
Cotton	44,451	648	27,329	394	39,733	37,283,704 pounds.
Tobacco	11,864	853	9,161	701	16,275	4,244,018 pounds.
Other special crops	2,004	186	1,260	161	1,939	
Home gardens	53,479	158,284	36,710	99,605	47,352	1,067,436 bushels.
Market gardens, truck and canning crops	6,620	6,065	4,343	3,357	4,315	344,898 bushels.
Beautification of home grounds	5,339	81,500	3,686	52,672	----------	
Tree fruits	1,888	9,110	1,083	4,534	9,199	62,249 bushels.
Bush and small fruits	1,835	9,464	1,380	3,666	1,396	33,041 bushels.
Grapes	325	5,540	213	1,595	328	3,943 bushels.
Forestry	15,523	5,300	10,799	3,900	[2] 63,095	

Project	Boys enrolled	Girls enrolled	Boys completing	Girls completing	Units involved in club work
Wildlife conservation	8,301	6,621	5,561	4,329	25,400 units.
Agricultural engineering	10,992	2,018	7,284	1,347	74,606 units.
Poultry	65,808	66,194	43,542	42,739	3,531,906 birds.
Dairy cattle	44,528	8,005	32,880	5,925	48,927 animals.
Beef cattle	29,534	2,771	21,603	2,225	32,057 animals.
Sheep	19,982	2,970	15,010	2,443	60,307 animals.
Swine	84,654	4,640	55,710	3,256	125,795 animals.
Horses and mules	7,874	453	5,881	357	6,923 animals.
Other livestock	2,914	338	1,867	222	9,741 animals.
Farm management	6,284	893	3,491	676	
Food selection	6,296	266,772	4,855	185,192	
Food preservation	1,217	218,597	595	139,351	8,219,108 jars.
Child training	153	5,674	92	4,014	
Clothing	1,329	411,645	951	293,392	330,694 dresses.
Home management	622	40,822	409	28,555	29,539 units.
House furnishings	1,296	129,113	817	87,499	56,884 rooms. 341,109 articles.
Handicraft	20,632	41,613	16,434	30,905	153,627 articles.
Home health and sanitation	52,006	165,928	36,154	114,047	
Beekeeping	1,516	154	1,087	115	5,300 colonies.
Leadership	3,539	5,839	2,698	4,635	
Miscellaneous	8,204	10,856	6,193	8,931	
Total	662,424	1,674,297	458,514	1,134,815	

[1] 1 club member may engage in 2 or more projects. The sum of the projects is, therefore, greater than the number of different clubs and club members involved.
[2] Includes transplant beds.

TABLE 11.—*Number of counties with county extension agents, July 1, 1938, 1937, 1930, and 1925, and total number of extension workers, July 1, 1938*

State	Counties in State	Counties with agents on July 1—								Total extension workers, July 1, 1938
		1938		1937		1930		1925		
		Men	Women	Men	Women	Men	Women	Men	Women	
Alabama	67	67	66	67	58	63	42	59	37	319
Arizona	14	12	[1] 10	11	[1] 10	12	11	12	9	36
Arkansas	75	75	75	75	75	63	53	50	39	247
California	58	42	30	43	30	41	[1] 33	43	22	188
Colorado	63	[1] 51	17	[1] 51	[1] 15	33	15	20	2	108
Connecticut	8	8	8	8	8	8	8	8	7	73
Delaware	3	3	3	3	3	3	3	3	-------	22
Florida	67	[1] 56	37	[1] 55	36	45	33	36	30	143
Georgia	159	[1] 159	91	[1] 159	[1] 88	108	72	121	61	370
Idaho	44	31	30	30	[1] 37	26	[1] 43	16	27	61
Illinois	102	[1] 101	[1] 60	[1] 100	[1] 56	93	29	95	21	224
Indiana	92	91	45	[1] 87	[1] 42	86	8	79	1	224
Iowa	99	99	[1] 77	99	[1] 63	99	[1] 27	99	15	288
Kansas	105	102	40	102	36	74	31	63	15	247
Kentucky	120	120	50	120	46	85	26	72	24	269
Louisiana	64	64	[1] 62	64	[1] 62	59	36	48	24	218
Maine	16	[1] 16	[1] 16	[1] 16	[1] 16	16	16	16	15	60
Maryland	23	23	23	23	23	23	23	23	19	101
Massachusetts	14	11	10	11	10	11	11	11	11	95
Michigan	83	[1] 81	[1] 40	[1] 77	[1] 40	65	9	57	5	180
Minnesota	87	87	23	[1] 87	22	62	10	58	8	245
Mississippi	82	82	71	82	[1] 77	66	56	54	44	318
Missouri	114	[1] 114	[1] 65	[1] 114	[1] 59	[1] 75	18	50	9	262
Montana	56	[1] 46	[1] 13	[1] 45	[1] 13	31	15	23	6	77
Nebraska	93	[1] 93	24	[1] 93	[1] 29	46	10	43	2	180
Nevada	17	[1] 14	[1] 5	[1] 15	[1] 6	13	[1] 9	8	9	25
New Hampshire	10	10	10	10	10	10	10	10	8	64
New Jersey	21	20	17	19	16	19	19	18	11	91
New Mexico	31	[1] 31	[1] 17	30	[1] 16	21	[1] 17	21	5	74
New York	62	55	40	55	38	55	41	55	38	322
North Carolina	100	100	79	100	76	82	56	74	49	372
North Dakota	53	50	11	52	7	34	8	33	1	102
Ohio	88	87	46	88	40	78	26	85	15	223
Oklahoma	77	77	77	77	77	72	59	65	44	230
Oregon	36	[1] 36	11	36	7	29	6	28	3	97
Pennsylvania	67	66	[1] 66	65	[1] 65	65	[1] 65	63	28	219
Rhode Island	5	[1] 5	[1] 5	[1] 5	[1] 5	[1] 5	[1] 5	5	2	26
South Carolina	46	46	46	46	46	45	46	40	38	194
South Dakota	69	[1] 62	[1] 37	[1] 62	[1] 30	32	[1] 47	34	32	122
Tennessee	95	95	66	95	64	81	49	50	26	318
Texas	254	[1] 254	180	[1] 254	172	178	118	155	88	634
Utah	29	[1] 25	[1] 8	25	[1] 8	22	[1] 10	18	11	62
Vermont	14	14	[1] 14	13	[1] 14	13	11	12	7	57
Virginia	100	[1] 99	[1] 57	98	[1] 53	77	40	65	35	294
Washington	39	39	[1] 18	38	10	29	11	26	5	104
West Virginia	55	48	[1] 34	48	[1] 30	43	26	36	15	148
Wisconsin	71	66	24	64	24	56	4	48	1	186
Wyoming	23	20	8	20	7	20	8	16	5	47
Alaska	-------	-------	-------	-------	-------	-------	-------	-------	-------	5
Hawaii	5	4	4	5	4	4	4	-------	-------	40
Puerto Rico	[2] 72	32	14	34	10	-------	-------	-------	-------	71
Total	3,147	[1] 2,989	[1] 1,880	[1] 2,976	[1] 1,789	[1] 2,376	[1] 1,333	2.124	929	8,682

[1] Some agents cover 2 or more counties.
[2] Municipalities.

TABLE 12.—*Expenditures of funds from all sources for cooperative extension work in States, Alaska, Hawaii, and Puerto Rico for the year ended June 30, 1937, by sources of funds, and totals for 1932–36*

State or Territory	Grand total	Total Federal funds	Total within the States	Funds from Federal sources						Funds from within States		
				U. S. Department of Agriculture		Clarke-McNary	Smith-Lever supplementary and Bankhead-Jones	Capper-Ketcham	Additional cooperative	State and college	County	Farmers' organizations, etc.
				Farmers' cooperative demonstrations	Other							
Alabama	$860,019.79	$607,239.02	$252,780.77			$1,620.00	$563,018.41	$37,600.61	$5,000.00	$52,949.22	$192,853.35	$6,978.20
Arizona	173,242.46	116,941.16	56,301.30				83,972.17	22,643.99	10,325.00	26,558.94	29,536.53	205.83
Arkansas	793,155.00	527,706.60	265,448.40	$3,985.33			467,103.25	33,618.02	23,000.00	129,798.57	135,649.83	
California	908,253.82	387,529.93	520,723.89	3,250.00		1,350.00	341,395.02	34,034.91	7,500.00	322,503.03	198,220.86	
Colorado	322,015.86	212,151.15	109,864.71	3,500.03		900.00	154,726.97	24,774.15	28,250.00	57,054.75	52,809.96	
Connecticut	308,627.80	130,796.77	177,831.03			997.33	99,352.63	24,396.81	6,050.00	124,607.93	40,562.25	12,660.85
Delaware	85,898.92	71,820.09	14,078.83				51,010.87	20,809.22		13,214.53	864.30	
Florida	441,665.71	217,110.89	224,554.82				172,607.95	26,555.74	17,947.20	119,226.06	105,328.76	
Georgia	986,436.42	675,947.39	310,489.03	4,999.92		1,620.00	599,199.32	38,628.15	31,500.00	73,883.13	326,605.90	
Idaho	272,367.74	155,745.57	116,622.17	3,491.02		1,620.00	110,314.73	22,919.82	17,400.00	63,012.75	53,609.42	
Illinois	1,029,926.02	511,233.73	518,692.29			1,620.00	448,652.95	38,460.78	22,500.00	127,297.02	4,590.60	386,804.67
Indiana	891,074.49	393,716.48	497,358.01	1,500.00		1,620.00	338,741.10	33,349.72	18,505.66	175,521.39	251,497.22	70,339.40
Iowa	1,077,760.05	488,592.83	589,167.22	2,076.63		1,620.00	432,592.71	33,803.49	18,500.00	208,971.68	291,069.14	89,126.40
Kansas	946,942.89	385,577.46	561,365.43	2,026.96		1,020.81	328,251.97	30,652.72	23,625.00	113,775.50	429,596.66	17,993.27
Kentucky	830,965.63	565,717.88	265,247.75				516,416.91	36,800.97	12,500.00	120,000.00	145,065.36	182.39
Louisiana	699,904.27	424,512.37	275,391.90	3,599.21		1,620.00	372,058.70	31,734.46	15,500.00	185,924.12	88,936.00	531.78
Maine	242,973.07	155,953.51	87,019.56				121,499.44	24,404.07	10,050.00	53,821.86	30,486.58	2,711.12
Maryland	400,045.10	196,893.70	203,151.40			1,619.94	156,647.15	26,076.61	12,550.00	118,475.94	63,696.00	20,979.46
Massachusetts	464,239.73	138,615.88	325,623.85	3,300.00		1,620.00	103,326.03	23,869.85	6,500.00	101,562.66	224,061.19	
Michigan	760,476.88	429,003.51	331,473.37			1,620.00	386,130.25	34,253.26	7,000.00	210,531.37	120,942.00	
Minnesota	746,678.65	435,458.95	311,219.70			1,620.00	388,750.29	32,088.66	13,000.00	152,762.73	152,632.30	5,824.67
Mississippi	941,824.55	594,787.84	347,036.71	1,651.58		1,620.00	551,053.33	35,462.93	5,000.00	109,616.05	233,885.66	3,535.00
Missouri	836,295.54	556,596.42	279,699.12				495,714.79	36,381.63	24,500.00	113,546.38	109,269.91	56,882.83
Montana	363,648.35	174,404.35	189,244.00	4,860.51		799.92	118,594.27	23,299.65	26,850.00	64,404.84	124,839.16	
Nebraska	541,575.09	345,128.23	196,446.86	2,879.99		1,620.00	270,975.13	28,253.11	41,400.00	78,414.01	83,589.80	34,443.05
Nevada	123,392.50	72,817.65	50,574.85	1,733.32			39,860.62	20,523.71	10,700.00	28,281.71	22,293.14	
New Hampshire	221,274.03	94,725.95	126,548.08			1,620.00	65,327.23	21,778.72	6,000.00	71,136.00	55,412.08	
New Jersey	412,732.52	172,701.66	240,030.86			1,620.00	133,234.62	26,497.04	11,350.00	84,664.89	152,774.10	2,591.87
New Mexico	219,276.61	142,397.99	76,878.62	2,700.00			102,619.13	22,928.86	14,150.00	33,981.14	41,750.63	1,146.85
New York	1,652,782.82	474,321.67	1,178,461.15			1,620.00	421,146.36	39,107.80	12,447.51	534,766.82	625,169.28	18,525.05
North Carolina	1,087,091.17	730,481.86	356,609.31	1,200.00		1,620.00	680,818.78	41,843.08	5,000.00	95,720.82	260,285.18	603.31
North Dakota	337,854.82	246,779.16	91,075.66	3,690.35		784.00	188,358.99	25,251.93	28,693.89	5,767.44	55,719.31	29,588.91

TABLE 12.—*Expenditures of funds from all sources for cooperative extension work in States, Alaska, Hawaii, and Puerto Rico for the year ended June 30, 1937, by sources of funds, and totals for 1932–36*—Continued

State or Territory	Grand total	Total Federal funds	Total within the States	Funds from Federal sources						Funds from within States		
				U. S. Department of Agriculture		Clarke-McNary	Smith-Lever supplementary and Bankhead-Jones	Capper-Ketcham	Additional cooperative	State and college	County	Farmers' organizations, etc.
				Farmers' cooperative demonstrations	Other							
Ohio	$1,002,241.50	$551,630.15	$450,611.35			$1,440.00	$505,393.13	$39,797.02	$5,000.00	$246,788.26	$20,823.09	
Oklahoma	776,499.25	510,357.16	266,142.09	$3,983.98			452,804.28	34,568.90	19,000.00	122,500.00	143,642.09	
Oregon	395,316.70	186,780.15	208,536.55	3,499.92			134,136.07	24,294.16	24,850.00	109,662.53	91,620.90	$7,253.12
Pennsylvania	911,140.88	497,640.90	413,499.98			1,260.00	443,963.93	48,666.97	3,750.00	279,927.43	133,572.55	
Rhode Island	68,867.76	46,984.25	21,883.51				26,502.42	20,481.81		5,011.40	15,663.13	1,208.98
South Carolina	607,306.32	447,638.22	159,668.10	1,200.00			402,781.85	32,656.37	11,000.00	142,000.00	17,668.10	
South Dakota	352,199.25	259,777.80	92,419.25	3,599.76			187,380.11	25,200.13	43,600.00	44,378.01	48,041.24	
Tennessee	783,088.40	580,737.67	202,350.73	3,957.07		1,620.00	517,243.80	35,916.80	22,000.00	120,875.68	81,475.05	
Texas	1,874,502.03	1,082,690.76	791,811.27	7,860.83		1,620.00	983,419.53	51,790.40	38,000.00	301,620.36	472,660.62	17,530.29
Utah	190,284.92	121,998.41	68,286.51	2,760.00		1,080.00	84,022.84	22,235.57	11,900.00	32,317.51	35,969.00	
Vermont	211,337.26	114,195.62	97,141.64			1,552.50	83,214.38	22,228.74	7,200.00	50,000.00	41,729.58	5,412.06
Virginia	840,208.15	504,890.48	335,317.67	4,081.07		1,620.00	439,672.19	35,142.22	24,375.00	213,226.79	116,337.00	5,753.88
Washington	319,315.11	217,602.11	101,713.00	3,499.59			175,570.47	26,282.05	12,250.00	8,623.57	93,089.43	
West Virginia	470,474.87	305,227.60	165,247.27			1,620.00	268,444.43	31,414.03	3,749.14	133,964.15	28,037.12	3,246.00
Wisconsin	719,690.74	431,793.41	287,897.33			1,620.00	394,855.31	32,818.10	2,500.00	93,851.42	194,045.91	
Wyoming	157,420.17	109,620.16	47,800.01	2,799.96		1,260.00	64,421.52	21,438.68	19,700.00	47,800.01		
Alaska	20,678.61	16,318.00	4,360.61	2,400.00			13,918.00			4,360.61		
Hawaii	137,381.47	113,152.12	24,229.35				91,196.91	21,955.21		24,229.35		
Puerto Rico	215,234.90	97,648.50	117,586.40	7,602.06		1,617.00	88,429.44			117,586.40		
Total, 1937	30,033,606.59	17,030,093.32	13,003,513.27	97,689.09		49,701.50	14,660,842.68	1,479,691.65	742,168.40	5,870,476.76	6,330,977.27	802,059.24
1936	28,299,905.64	16,190,624.41	12,109,281.23	179,708.02		48,323.51	13,502,153.16	1,479,971.78	980,467.94	5,220,032.99	5,887,700.67	1,001,547.57
1935	20,440,902.01	8,945,153.85	11,495,748.16	251,187.12		43,981.94	6,196,581.60	1,472,568.37	980,834.82	5,089,445.11	5,457,263.66	949,039.39
1934	19,844,167.34	9,216,781.45	10,627,385.89	725,094.48	$32,014.14	44,754.27	5,994,193.65	1,446,597.52	974,127.39	4,778,604.71	5,020,594.52	828,186.66
1933	21,976,841.08	9,410,053.31	12,566,787.77	865,635.74	38,839.45	60,370.93	6,039,834.67	1,458,159.68	947,212.84	6,146,294.51	5,623,467.93	797,025.33
1932	24,298,649.15	9,650,653.37	14,647,995.78	929,632.27	39,099.84	60,444.25	6,157,730.01	1,479,596.91	984,150.09	6,919,826.62	6,628,514.35	1,099,654.81

TABLE 13.—*Expenditures of funds from all sources for cooperative extension work in States, Alaska, Hawaii, and Puerto Rico for the year ended June 30, 1937, by projects, and totals for 1932–36*

State	Totals	Administration	Printing and distribution of publications	County agent work	Home demonstration work	Boys' and girls' club work	Home economics specialists	Extension schools	Animal husbandry	Poultry	Dairying	Animal diseases	Agronomy	Foods and nutrition
Alabama	$860,019.79	$20,833.34	$8,286.39	$468,496.23	$255,482.99	$17,472.51		$3,793.70	$12,711.64	$6,355.82			$8,658.08	$6,709.63
Arizona	173,242.46	18,255.64	1,109.24	83,647.08	29,187.29	4,559.60			5,112.45	2,434.64	$2,412.06		4,569.59	
Arkansas	793,155.00	26,863.63	17,622.56	364,465.40	298,668.83	9,087.20		4,790.45	5,019.31	3,947.79	4,117.51		3,237.18	6,211.72
California	908,253.82	14,991.44		600,161.74	152,982.74	21,092.53		8,198.35	4,562.98	4,326.94	8,895.54		9,348.37	4,259.40
Colorado	322,015.86	13,002.51	3,828.82	182,167.48	33,367.74	8,413.07			4,969.52	4,808.05	7,750.73	$2,886.25	10,578.95	3,692.45
Connecticut	308,627.80	14,978.59	5,641.21	67,190.80	36,385.03	68,750.84	$3,472.07	1,212.48	2,472.77	9,788.31	12,132.90		8,154.67	4,117.52
Delaware	85,898.92	10,768.12	961.45	20,036.82	15,887.73	19,451.19								1,900.66
Florida	441,665.71	16,329.81	8,664.89	185,875.00	116,882.70	6,286.31		37.35	5,720.95	9,869.57	5,030.00			4,662.40
Georgia	986,436.42	57,316.73	12,835.27	588,935.12	208,918.61	16,497.82			7,857.02	3,524.37	3,674.70		7,829.87	7,148.91
Idaho	272,367.74	14,253.62	4,734.34	154,258.31	29,000.59	6,054.24		148.60	6,356.53	5,783.75	5,976.99		14,635.97	
Illinois	1,029,926.02	52,276.73	18,399.14	589,805.16	186,096.75	39,845.16	6,136.68		7,617.82	4,099.99	14,361.56	2,539.78	17,136.08	6,395.63
Indiana	891,074.49	30,621.97	6,493.60	479,399.08	82,565.85	126,183.34		27,078.82	17,604.89	9,016.06	13,046.08	32.60	13,869.86	5,945.32
Iowa	1,077,760.05	66,807.62	10,925.32	545,755.79	104,999.78	97,582.39		1,707.88	9,851.35	6,818.36	42,235.56	5,078.82	13,494.70	10,362.08
Kansas	946,942.89	42,856.38	2,389.35	563,806.86	119,673.89	28,849.44	2,921.98	28,097.71	8,130.26	7,083.73	9,160.64	3,620.36	11,042.88	5,946.09
Kentucky	830,965.63	24,578.06	9,140.35	514,337.38	126,171.59	41,406.59		4,872.29	14,286.81	10,249.72	6,204.10	3,707.15	16,633.34	7,555.21
Louisiana	699,904.27	34,471.23	13,617.76	352,895.99	180,238.55	13,550.24			9,908.02	5,678.88	6,976.13		7,377.35	8,272.75
Maine	242,973.07	23,988.84	2,938.76	73,281.13	54,481.27	28,652.70				4,326.00	7,158.39		9,245.52	3,064.06
Maryland	400,045.10	26,537.09	2,040.63	128,079.76	101,867.11	11,432.30		4,345.71	8,620.89	7,619.14	9,916.14		8,150.06	3,554.33
Massachusetts	464,239.73	13,207.33	5,079.67	103,523.95	90,734.47	126,503.00		3,627.31	5,051.68	5,909.21	58.19		6,361.74	5,005.09
Michigan	760,476.88	15,644.01	18,875.45	318,462.28	69,455.17	109,187.86			11,571.99	12,397.55	21,862.29	5,366.23	33,068.35	3,906.98
Minnesota	746,678.65	31,437.02	13,160.76	416,580.60	65,761.95	96,551.49			9,601.72	4,007.01	15,321.32	4,340.51	13,399.44	7,060.64
Mississippi	941,824.55	54,179.22	9,187.15	490,277.00	239,310.28	26,757.20			9,230.48	8,663.51	9,447.91		5,760.12	9,104.22
Missouri	836,295.54	22,259.96	11,648.74	541,440.49	115,957.56	19,149.78		805.96	9,777.66	8,927.58	10,931.61	3,185.97	14,546.77	7,440.20
Montana	363,648.35	21,438.82	6,397.10	201,250.39	54,145.04	9,405.71		231.37	4,375.22	5,289.09	4,276.86	1,081.64	5,949.10	3,548.28
Nebraska	541,575.09	19,299.90	10,028.16	308,301.93	60,550.54	21,544.91			7,563.12	9,790.27	8,261.81		12,908.31	7,087.59
Nevada	123,392.50	13,383.17	728.00	65,816.19	28,689.52									
New Hampshire	221,274.03	18,441.58	2,949.83	48,071.98	38,411.12	57,084.49		1,025.33		6,413.11	7,149.06		3,483.37	3,315.14
New Jersey	412,732.52	15,608.78	1,458.35	134,447.09	77,140.04	65,894.30				11,419.49	12,296.67		8,060.16	6,498.70
New Mexico	219,276.61	15,501.22	8,523.39	102,740.01	44,401.29	3,697.43			4,628.38	4,722.98	5,731.93		5,018.76	
New York	1,652,782.82	129,417.65	66,697.95	475,369.94	264,908.75	250,993.21	21,604.65	48,422.82	576.43	48,194.33	62,070.28		27,140.70	19,437.78
North Carolina	1,087,091.17	32,429.53	9,069.59	650,657.04	235,293.36	8,603.39	2,329.96		15,299.54	11,988.49	15,299.54		13,531.26	6,094.01
North Dakota	337,854.82	12,223.66	5,069.59	197,466.66	24,919.35	23,696.08			5,025.49	5,922.11			5,067.26	10,555.35
Ohio	1,002,241.50	32,439.76	16,799.77	518,238.12	120,180.15	53,638.70		30,768.41	26,181.37	13,780.13	3,160.11		29,228.87	7,378.04
Oklahoma	776,499.25	36,588.15	10,395.72	318,223.44	270,709.00	21,667.11			4,867.53	9,108.48	9,540.98		12,969.67	7,340.88
Oregon	395,316.70	22,732.34	3,975.35	195,320.49	39,785.96	53,687.25			5,429.61	4,049.64	4,921.96		15,739.46	3,062.02
Pennsylvania	911,140.88	55,903.66	4,796.89	392,723.10	174,593.81	38,036.53			17,381.10	19,535.56	35,822.33		19,597.27	5,440.03
Rhode Island	68,867.76	3,515.63	185.00	14,862.88	14,332.82	17,477.49				3,270.35	2,225.67		926.54	1,483.66
South Carolina	607,306.32	33,916.46	6,990.56	297,486.73	148,494.57	13,524.37			8,817.09	7,767.76	8,912.33		7,998.42	3,619.45

TABLE 13.—*Expenditures of funds from all sources for cooperative extension work in States, Alaska, Hawaii, and Puerto Rico for the year ended June 30, 1937, by projects, and totals for 1932–36*—Continued

State	Totals	Administration	Printing and distribution of publications	County agent work	Home demonstration work	Boys' and girls' club work	Home economics specialists	Extension schools	Animal husbandry	Poultry	Dairying	Animal diseases	Agronomy	Foods and nutrition
South Dakota	$352,199.25	$14,926.81	$6,338.85	$200,404.41	$46,937.55	$25,241.61			$5,333.72	$3,590.30	$4,482.95	$3,880.56	$5,769.26	$4,680.41
Tennessee	783,088.40	27,242.24	7,232.89	390,552.20	222,978.72	12,684.98	$3,530.65	$4,408.42	12,866.89	5,352.30	9,556.26		9,161.23	3,887.57
Texas	1,874,502.03	66,461.72	31,779.84	984,259.60	623,684.13	8,267.43			27,843.33	9,434.07	12,089.36		10,354.82	7,942.22
Utah	190,284.92	25,297.18	533.62	93,432.01	28,259.50	6,395.11			2,669.44	3,712.62	5,120.58		3,586.68	3,089.90
Vermont	211,337.26	20,916.86	2,474.67	49,723.10	43,518.42	51,672.97				3,525.96	4,681.22		3,218.62	3,318.63
Virginia	840,208.15	27,359.95	10,998.23	497,334.45	147,449.14	8,639.06			13,418.61	11,828.41	20,272.22		14,056.65	4,940.14
Washington	319,315.11	20,770.79	8,138.52	196,503.41	32,550.62	15,321.19			3,859.92	4,595.82	3,795.08		3,895.99	3,389.33
West Virginia	470,474.87	30,060.11	13,405.82	198,414.23	81,131.95	75,066.98			8,817.87	4,810.37	6,164.77		3,922.07	3,209.57
Wisconsin	719,690.74	22,786.32	21,435.00	303,871.85	66,498.94	42,931.09			21,725.34	9,362.35	39,261.05		39,513.89	11,127.24
Wyoming	157,420.17	17,669.06	1,079.20	70,792.65	25,106.49	11,799.77			2,360.76	3,982.98	2,317.55		5,862.50	3,647.51
Alaska	20,678.61	2,656.48	126.50	6,901.24	5,675.32							5,319.07		
Hawaii	137,381.47	18,940.85	1,785.82	44,282.16	45,289.52		3,700.00		3,977.99				6,469.32	
Puerto Rico	215,234.90	29,904.94	1,495.75	90,643.63	38,910.22	1,939.72			3,078.08				43,369.78	
Total, 1937	30,033,606.59	1,434,292.51	448,470.81	14,880,970.38	5,718,624.31	1,842,227.68	43,695.99	173,572.96	382,133.57	367,082.95	504,080.92	41,038.94	553,898.85	256,408.74
1936	28,299,905.64	1,595,504.83	467,762.24	14,320,269.28	5,051,403.27	1,692,015.58	40,970.45	159,712.80	423,769.99	334,575.81	407,046.17	43,475.43	505,716.36	229,906.64
1935	20,440,902.01	1,191,666.06	308,231.36	9,559,843.54	3,976,205.12	1,472,033.30	25,107.99	153,674.93	289,178.87	302,720.98	334,769.46	39,030.57	329,667.79	192,418.13
1934	19,844,167.34	1,089,134.54	258,509.98	9,610,515.68	3,675,904.82	1,323,486.65	24,794.36	155,446.13	315,866.16	305,912.64	334,622.23	37,638.76	335,180.85	181,941.20
1933	21,976,841.08	1,273,621.23	328,555.12	10,264,949.45	4,048,793.31	1,524,012.10	30,659.07	206,836.46	382,261.69	351,338.12	378,878.59	42,040.07	384,245.28	198,934.40
1932	24,298,649.15	1,245,641.92	364,305.05	11,464,026.65	4,520,791.25	1,636,907.05	41,802.30	238,038.81	400,190.14	387,298.80	466,049.32	44,614.98	441,247.78	210,592.97

TABLE 13.—*Expenditures of funds from all sources for cooperative extension work in States, Alaska, Hawaii, and Puerto Rico for the year ended June 30, 1937, by projects, and totals for 1932–36*—Continued

State	Child care and training	Clothing	Home management	Horticulture	Botany and plant pathology	Entomology, apiculture, ornithology	Rodent pests	Forestry	Agricultural engineering	Rural organization	Agricultural economics			Exhibits and fairs	Publicity	Miscellaneous specialists
											Farm management	marketing	General			
Alabama		$4,001.09	$3,894.05	$5,399.65		$3,183.28		$3,952.84	$9,136.43				$15,864.86		$4,560.83	$1,226.43
Arizona		3,465.40	3,712.92	3,936.65						$4,242.38	$1,801.88		1,801.87		2,993.77	
Arkansas		3,240.92	6,453.38	2,828.79				2,242.84	3,752.78	7,036.45	3,450.61	$5,808.62	3,646.22		10,662.81	
California	$648.69	4,079.65	3,827.39	5,513.39	$3,797.85			5,020.95	9,024.34		11,340.75	5,291.01	4,167.53	$9,048.35		17,673.89
Colorado	3,712.36	3,525.95	3,747.28	2,343.48	3,729.88	4,673.83		3,290.71		4,936.39	6,685.52				9,904.89	
Connecticut		4,247.43	4,816.18	11,586.47		1,090.36		5,857.58	7,645.60	5,119.45	13,392.33	11,015.38	1,064.51	1,979.18	6,516.14	
Delaware			3,244.94		335.83	3,051.77							5,196.66		5,063.75	
Florida		3,546.64	3,760.74	1,556.58	1,556.57	20,485.34					9,855.95	6,570.63			5,698.77	29,275.51
Georgia	3,351.07	3,337.02	6,638.08	7,487.25	3,289.10			5,636.77	12,530.86		3,920.00	17,854.96			7,852.89	
Idaho		4,398.01		4,978.64		2,814.33	$5,511.47	3,690.88			9,771.47					
Illinois	3,075.26	3,539.79	9,697.90	9,980.00				5,134.34	8,004.47	7,588.13	6,345.29	6,345.29	12,690.58		9,367.94	3,446.55
Indiana		2,789.78	5,909.84	14,640.36	8,447.80	3,526.39		8,348.20	8,573.11		16,108.91	6,807.92			4,064.71	
Iowa	3,257.67	6,881.42	13,558.06	21,165.39	11,822.51	11,299.94		3,366.27	7,788.87	10,192.92	13,843.11	22,651.64	2,149.05	2,830.11	25,474.35	5,859.09
Kansas		4,928.99	7,941.07	10,657.54	2,931.92	4,276.01		2,162.39	14,616.89		35,796.32	12,448.13			17,604.06	
Kentucky		7,838.12	4,019.62	11,380.68					8,457.38	1,486.08	7,339.60	6,756.23			4,545.33	
Louisiana			3,966.86	14,417.93		1,989.52		3,626.14	12,307.54	9,505.94	7,012.94	1,801.82		8,656.04	3,632.64	
Maine		3,044.58	4,451.15					3,452.89	3,548.84		6,105.22	8,850.92			6,382.80	
Maryland		3,788.85	3,238.17	14,329.43	10,652.61	16,083.17		3,273.39	4,491.11	829.42	4,540.91	16,728.50			9,926.38	
Massachusetts	4,980.82	5,141.12	8,321.05	18,264.18	5,287.76			4,505.12	5,481.24	10,025.44	11,865.24	11,865.25		1,525.68	11,915.19	
Michigan	3,271.46	6,579.63	14,713.93	21,182.33	2,329.60	3,823.53		4,448.53	11,990.00		15,135.47	9,884.68	14,827.03		31,445.92	1,046.61
Minnesota	3,426.66	7,026.10	6,591.34	3,004.03	4,097.85	3,232.30		5,384.91	2,445.91		11,961.80	11,175.36			6,558.27	4,551.66
Mississippi		4,277.01	3,795.75	6,953.69				4,689.56	14,579.97	9,757.44	3,925.00	25,111.52			6,817.52	
Missouri		5,853.26	7,755.38	7,010.42		3,765.84		4,108.80	15,785.60		7,724.24	11,953.38			6,266.34	
Montana		4,014.82	3,852.29	3,457.74	947.19	1,912.46		1,599.84	6,616.23		10,461.55		5,257.96		4,934.18	3,205.47
Nebraska		2,631.17	11,620.70	6,280.59		3,142.95		6,653.55	13,597.99	7,350.66	12,785.04	4,471.40			7,704.50	
Nevada													12,943.62		1,832.00	
New Hampshire		3,150.15	3,668.64	6,712.13				7,181.34	1,424.68	5,284.96	3,227.67	4,279.45				
New Jersey	7,041.18	4,493.59	4,083.42	19,458.70				5,039.65	5,089.95	4,140.80	5,533.76	9,476.60			15,551.29	
New Mexico			3,685.77	5,308.88					2,860.97				9,155.60		3,300.00	
New York	9,504.54	12,110.29	20,524.02	34,934.26	20,754.07	16,924.30		8,141.74	21,062.14	15,061.53	22,202.24	22,202.25			34,526.95	
North Carolina		6,478.65	7,016.25	9,289.42	4,487.05	7,139.08		9,475.63	16,970.30		2,760.00	9,703.39			13,175.69	
North Dakota	3,100.92	7,130.85	6,595.34	1,389.16	2,368.77	2,368.78		1,568.00	4,639.82	1,136.13	2,407.79	4,347.97			10,855.74	
Ohio	3,938.98	8,109.30	12,872.42	22,899.16	5,305.39	8,501.23		4,527.03	15,996.88	7,118.47	24,449.65	16,095.09			20,634.47	
Oklahoma	3,871.47	4,350.97	6,536.07	12,479.63		6,611.77			10,556.87		9,380.70	6,402.68			14,898.13	
Oregon	3,635.38	1,614.73	2,854.28	5,185.56			4,886.87		3,534.50	7,939.32		4,710.39	8,231.46	2,329.42	1,574.34	116.37
Pennsylvania		5,980.73	7,675.27	24,269.68	22,655.26	22,738.62		9,078.04	6,858.55		9,021.08	7,133.17	14,266.35		17,633.85	

TABLE 13.—*Expenditures of funds from all sources for cooperative extension work in States, Alaska, Hawaii, and Puerto Rico for the year ended June 30, 1937, by projects, and totals for 1932–36*—Continued

State	Child care and training	Clothing	Home management	Horticulture	Botany and plant pathology	Entomology, apiculture, ornithology	Rodent pests	Forestry	Agricultural engineering	Rural organization	Agricultural economics			Exhibits and fairs	Publicity	Miscellaneous specialists
											Farm management	marketing	General			
Rhode Island		$1,391.47		$3,005.22						$2,408.37			$2,889.25		$893.41	
South Carolina		2,894.09	$2,834.10	10,232.19		$7,329.61			$7,028.98	4,101.32	$1,480.00	$15,252.56	5,231.84	$6,571.80	6,822.09	
South Dakota		3,781.83	3,529.18	301.20		301.20		$4,262.73	2,476.96	3,066.88	6,184.39	1,106.76		3,232.90	2,368.79	
Tennessee		4,253.85		4,634.07				3,645.88	6,864.94		26,938.48	17,278.25			10,018.58	
Texas	$2,667.41	4,827.37	14,328.18	9,504.31		5,192.41		4,199.74	16,207.56	6,004.24	15,159.40				9,196.87	$5,098.02
Utah		5,383.50	3,259.23	3,581.43				2,160.00					3,006.89		797.23	
Vermont		3,779.60	3,988.94	3,322.90				3,111.40	4,038.73		3,197.63	3,461.21			3,386.40	
Virginia		3,600.04	2,642.78	23,410.54	$4,030.39			3,844.64	14,254.68	6,570.63	4,154.96	9,512.48	4,716.64		7,173.51	
Washington		3,461.79	4,265.29	4,667.77		605.08							10,340.04		3,154.47	
West Virginia				14,467.12	3,120.35			5,733.14		13,602.25			4,059.70		4,324.57	164.00
Wisconsin	3,629.08	9,709.30	6,661.61	17,850.56	9,495.06			10,371.42	7,678.92	15,743.01	18,281.26	16,082.84			25,674.61	
Wyoming		3,672.71		2,120.00				2,520.00					4,488.99			
Alaska																
Hawaii				4,268.50									8,667.31			
Puerto Rico								3,234.00							2,658.78	
Total, 1937	63,112.95	202,351.56	266,548.86	451,647.60	131,442.81	166,063.10	$10,398,34	178,540.88	327,920.59	170,248.61	385,548.16	350,437.73	154,663.96	36,173.48	420,345.75	71,663.60
1936	54,732.12	181,727.56	232,743.10	416,944.43	120,487.63	164,480.88	16,013.17	152,053.63	281,111.17	139,672.62	407,956.84	339,883.58	111,120.32	21,943.37	350,948.12	35,958.25
1935	29,831.54	164,646.85	185,276.15	357,235.88	103,553.99	127,935.36	11,268.31	130,921.51	175,434.43	87,494.05	259,103.98	236,785.87	105,514.09	17,039.93	252,886.45	21,425.52
1934	35,482.04	155,305.04	191,038.51	346,957.98	94,776.31	124,014.30	9,164.90	124,165.32	157,615.99	80,606.89	261,089.91	257,404.93	73,717.17	13,715.12	251,722.88	18,436.05
1933	34,558.25	169,724.73	198,835.62	402,637.81	106,801.75	146,023.12	9,432.70	153,804.09	183,801.81	70,072.75	317,280.47	437,415.22	13,848.70	14,229.16	265,259.13	37,990.88
1932	28,431.97	188,604.42	206,393.53	463,623.95	106,860.53	156,613.52	9,171.19	166,289.54	194,573.76	67,053.26	321,037.68	395,860.21	121,206.97	15,459.63	255,936.88	140,025.09

TABLE 14.—*Expenditures of funds from all sources for cooperative extension work in States, Alaska, Hawaii, and Puerto Rico for the year ended June 30, 1937, by items of expense, and totals for 1932–36*

State	Total appropriation	Personal services—salaries and labor	Printing, binding, and cuts for publications	Supplies and materials	Communication service	Transportation of things	Heat, light, water, and power	Equipment	Travel expenses	Miscellaneous
Alabama	$860,019.79	$645,792.29	$8,164.70	$15,277.85	$5,274.15	$2,649.41	$623.90	$35,249.64	$143,972.68	$3,015.17
Arizona	173,242.46	121,464.16	1,109.24	5,451.52	2,773.42	142.19	117.62	5,321.28	27,455.48	9,407.55
Arkansas	793,155.00	639,948.89	13,878.40	14,801.40	5,158.50	391.97	492.69	10,598.92	104,736.52	3,147.71
California	908,253.82	719,375.39	----------	28,799.05	13,034.91	810.17	1,744.28	17,261.00	117,435.79	9,793.23
Colorado	322,015.86	238,467.24	2,136.78	11,337.60	5,632.21	432.77	116.28	1,999.38	61,244.24	649.36
Connecticut	308,627.80	235,882.56	4,235.87	11,627.48	7,719.81	202.12	54.45	4,721.76	38,741.01	5,442.74
Delaware	85,898.92	64,522.77	932.13	2,157.56	1,625.51	36.32	52.80	2,769.04	13,012.35	790.44
Florida	441,665.71	362,867.23	10,959.07	14,166.10	2,088.76	993.60	175.09	9,113.80	39,058.23	2,243.83
Georgia	986,436.42	906,960.97	7,051.05	12,267.91	3,705.50	125.28	2,415.00	3,627.63	49,915.06	368.02
Idaho	272,367.74	193,221.39	3,589.71	10,262.15	4,530.79	978.72	98.75	8,864.30	46,923.54	3,898.39
Illinois	1,029,926.02	732,665.68	12,680.80	55,284.38	19,900.91	1,983.79	10,002.68	36,921.63	82,693.38	77,792.77
Indiana	891,074.49	659,286.12	4,979.97	26,941.42	4,869.87	585.47	379.64	8,763.48	112,170.92	73,097.60
Iowa	1,077,760.05	778,586.46	26,866.42	51,915.77	32,083.11	2,118.73	18,878.10	16,131.47	148,451.35	2,728.64
Kansas	916,942.89	641,382.69	932.45	46,812.39	21,299.51	1,690.94	7,396.32	40,597.70	111,918.73	74,912.16
Kentucky	830,965.63	734,183.25	6,287.08	9,694.63	1,841.49	95.50	3,600.00	4,401.82	70,577.60	284.26
Louisiana	699,904.27	599,771.27	14,009.01	9,466.10	2,245.40	863.54	1,200.00	8,744.17	60,493.43	3,111.35
Maine	242,973.07	172,989.11	2,488.76	12,408.69	6,101.10	464.81	1,461.67	4,174.37	42,382.97	501.59
Maryland	400,045.10	294,328.07	2,040.63	11,945.52	3,185.68	1,425.23	782.75	1,497.23	77,135.46	7,704.53
Massachusetts	464,239.73	355,177.78	5,079.67	7,763.17	2,260.61	277.95	----------	931.41	60,830.31	31,918.83
Michigan	760,476.88	503,402.12	16,511.81	22,747.34	3,274.56	367.35	----------	2,624.47	210,394.33	1,154.90
Minnesota	746,678.65	555,323.58	9,235.07	25,857.75	11,621.48	1,143.35	459.35	7,041.19	132,261.44	3,735.44
Mississippi	941,824.55	849,523.80	9,187.15	10,718.92	3,879.45	1,074.05	1,699.03	4,775.78	58,772.50	2,193.87
Missouri	836,295.54	665,742.27	8,634.89	22,929.01	13,121.66	632.08	1,212.64	15,042.22	102,452.16	6,528.61
Montana	363,648.35	271,561.76	6,348.95	23,443.18	2,615.20	280.62	746.66	3,235.26	55,401.72	15.00
Nebraska	541,575.09	412,888.74	5,616.27	24,578.65	9,528.61	794.31	1,227.90	6,886.18	68,629.12	11,425.31
Nevada	123,392.50	87,087.56	719.85	4,267.25	4,155.58	222.52	61.00	7,676.64	18,164.20	1,037.90
New Hampshire	221,274.03	152,026.24	3,990.87	8,965.72	4,390.97	473.72	700.00	2,420.13	43,154.56	5,151.82
New Jersey	412,732.52	339,789.79	718.35	14,122.77	7,876.32	115.36	991.57	11,463.20	31,713.83	5,941.33
New Mexico	219,276.61	148,280.99	2,784.26	7,378.12	3,368.34	301.40	619.50	4,588.79	49,816.11	2,139.10
New York	1,652,782.82	1,091,771.16	66,697.95	79,208.30	47,186.16	499.90	47,529.40	55,424.26	191,280.55	73,185.14
North Carolina	1,087,091.17	845,458.99	5,139.59	13,388.90	4,432.14	564.09	3,011.85	6,401.29	203,928.47	4,765.85
North Dakota	337,854.82	262,604.67	3,392.54	8,675.74	5,747.98	452.99	1,994.02	5,635.08	48,621.10	730.70
Ohio	1,002,241.50	778,152.05	12,695.39	26,529.41	13,597.72	1,094.25	458.27	10,956.41	149,373.46	9,384.54
Oklahoma	776,499.25	647,058.55	7,309.40	27,241.29	9,384.78	478.78	----------	7,773.69	76,069.89	1,182.87
Oregon	395,316.70	280,090.33	4,276.01	19,063.58	9,605.93	869.44	250.21	17,140.42	57,970.35	6,050.43
Pennsylvania	911,140.88	654,128.04	4,888.03	16,863.11	10,714.70	297.79	1,551.11	2,501.76	154,350.72	65,845.62
Rhode Island	68,867.76	49,132.88	340.91	2,035.27	1,307.40	24.02	----------	1,186.94	8,033.98	6,806.36
South Carolina	607,306.32	474,713.39	5,463.77	10,651.59	6,768.06	683.55	413.43	9,381.58	95,305.87	3,925.08
South Dakota	352,199.25	271,344.74	3,349.80	15,068.33	5,852.89	345.71	----------	3,646.68	52,031.55	559.55
Tennessee	783,088.40	697,040.17	7,232.89	17,020.27	7,520.15	911.69	1,459.80	3,955.16	41,974.05	5,974.22

TABLE 14.—*Expenditures of funds from all sources for cooperative extension work in States, Alaska, Hawaii, and Puerto Rico for the year ended June 30, 1937, by items of expense, and totals for 1932–36*—Continued

State	Total appropriation	Personal services—salaries and labor	Printing, binding, and cuts for publications	Supplies and materials	Communication service	Transportation of things	Heat, light, water, and power	Equipment	Travel expenses	Miscellaneous
Texas	$1,874,502.03	$1,523,845.57	$19,022.83	$23,409.84	$8,224.11	$152.00	$2,180.75	$4,298.22	$292,840.36	$528.35
Utah	190,284.92	141,618.94	526.72	6,867.38	2,501.29	87.02		1,146.38	37,096.45	440.74
Vermont	211,337.26	152,903.43	2,474.67	10,060.32	3,188.01	232.51	1,234.21	1,470.55	34,753.55	5,020.01
Virginia	840,208.15	711,077.69	8,149.90	10,748.42	3,918.99	442.63	184.11	3,520.27	99,229.88	2,936.26
Washington	319,315.11	248,198.28	7,036.90	9,588.32	4,330.24	1,333.35		2,033.94	45,693.74	1,100.34
West Virginia	470,474.87	411,157.80	5,702.30	10,279.31	2,584.23	142.66	2,007.71	4,152.74	32,475.34	1,972.78
Wisconsin	719,690.74	536,929.98	10,452.93	16,317.97	7,884.11	6.23	30.00	2,443.94	143,102.54	2,523.04
Wyoming	157,420.17	132,763.22	1,079.20	6,631.34	1,196.44	653.16		814.84	14,276.97	5.00
Alaska	20,678.61	14,706.56	126.50	847.82	78.90	148.34		787.00	3,969.69	13.80
Hawaii	137,381.47	100,438.87	1,836.57	4,707.94	1,904.74	303.41		4,050.10	23,411.62	728.22
Puerto Rico	215,234.90	145,767.68	1,495.75	7,612.40	2,402.23	455.95	597.34	7,564.07	42,540.47	6,799.01
Total, 1937	30,033,606.59	23,253,403.16	369,859.76	866,206.25	369,494.61	31,852.74	120,211.88	443,729.21	4,028,239.62	550,609.36
1936	28,299,905.64	21,332,240.03	393,391.87	937,710.89	405,600.53	45,026.22	118,201.59	728,562.09	3,734,661.25	604,511.17
1935	20,440,902.01	15,215,545.45	261,763.38	752,735.57	375,656.88	35,447.46	114,896.41	397,970.68	2,818,396.37	468,489.81
1934	19,844,167.34	15,301,148.50	213,666.81	634,972.02	328,366.83	34,349.80	90,407.33	302,634.80	2,488,269.24	450,352.01
1933	21,976,841.08	17,270,232.51	308,498.89	590,488.01	297,751.47	32,107.68	87,879.83	171,009.08	2,521,981.83	696,891.78
1932	24,298,649.15	18,881,463.69	322,413.14	700,070.58	315,232.22	36,251.53	100,639.59	305,586.59	2,935,158.37	701,833.44

U. S. GOVERNMENT PRINTING OFFICE: 1939

REPORT OF THE DIRECTOR OF FINANCE, 1937

United States Department of Agriculture,
Office of Budget and Finance,
Washington, D. C., October 11, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I submit herewith the report of the Office of Budget and Finance for the fiscal year ended June 30, 1937.

Sincerely,

W. A. Jump, *Director.*

CONTENTS

THE DEPARTMENT BUDGET

REGULAR AND EMERGENCY FUNDS DEFINED

As used in this report, the term "regular funds" refers to all appropriations made directly for conducting the activities of the Department of Agriculture. Included in this category are the current general operations of the various bureaus and offices of the Department and the road-construction work supported by the annual appropriation acts and acts supplementary thereto such as deficiency appropriation acts, laws relating to receipts and contributed funds made annually available for administration by the Department, the activities of the Agricultural Adjustment Administration and the programs authorized under the Bankhead-Jones Farm Tenant Act, and other special laws appropriating funds which augment or extend its regular or normal work.

The term "emergency funds" relates to the appropriations or allocations which the Department of Agriculture has received under acts or parts of acts passed by Congress specifically to meet unemployment or other emergency situations. The acts providing emergency appropriations from which funds were made available to this Department during the fiscal years 1931 to 1937, inclusive, and which are reported in the accompanying statistical tables, include the Emergency Construction Act of December 20, 1930, the Emergency Relief and Construction Act of July 21, 1932, the National Industrial Recovery Act of June 16, 1933, section 8 of the Jones-Costigan Sugar Act of May 9, 1934, relating to Puerto Rico and Hawaii trust funds (continuing under the item "Payments for agricultural adjustment" in the Supplemental Appropriation Act, 1936), the Emergency Appropriation Act, 1935 (June 19, 1934), the Emergency Relief Appropriation Act of

1935 (April 8, 1935), and the Emergency Relief Appropriation Act of 1936 (June 22, 1936).

Amounts allocated and obligated for the work of the Civilian Conservation Corps on national-forest and other lands are not included in this report, the work being financed and accounted for through the War Department.

REGULAR FUNDS

During the fiscal year 1937, the regular appropriations of the Department aggregated $730,668,805, and the total obligations incurred were $863,603,905, as shown in table 1.

TABLE 1.—*Regular appropriations and obligations of the Department of Agriculture, fiscal year 1937*

Item	Appropriations, 1937	Obligations, 1937
Agricultural Adjustment Administration	$549, 139, 621	$520, 543, 104
Road funds	68, 000, 000	216, 878, 171
Payments to States for experiment stations, extension work, and cooperative forestry activities, including fire prevention	24, 470, 600	24, 317, 982
All other purposes	89, 058, 584	101, 864, 648
Total	730, 668, 805	863, 603, 905

The excess of obligations over appropriations for roads in 1937 is accounted for by the fact that road funds authorized for the fiscal year 1938 ($216,500,000) were actually made available for contractual obligations in 1937, as authorized by the Highway Act of June 16, 1936. In like manner, the $68,000,000 appropriated for road work in 1937 was actually obligated in 1936.

The excess of obligations over appropriations in the item "all other purposes" in table 1 is due to the availability of unexpended balances of funds provided by section 37 of the act of August 24, 1935, and the Jones-Connally Act for the elimination of diseased cattle, which were obligated in 1937.

EMERGENCY FUNDS

In addition to the regular budget, emergency funds amounting to $258,348,549 were allocated to the Department in the fiscal year 1937. During that year obligations totaling $269,659,537 were incurred against these allocations and balances from allocations made in prior years, as shown in table 2.

TABLE 2.—*Emergency funds allocated to the Department of Agriculture, fiscal year 1937*

Act	Allocations, 1937	Obligations, 1937
National Industrial Recovery Act	$328, 600	$2, 522, 862
Emergency Appropriation Act, 1935	50, 000	348. 841
Supplemental Appropriation Act, 1936 (substitution for Puerto Rico and Hawaii trust funds under appropriation, Payments for agricultural adjustment)		290, 058
Emergency Relief Appropriation Act of 1935	7, 272, 269	54, 489, 498
Emergency Relief Appropriation Act of 1936	250, 697, 680	212, 008, 278
Total	258, 348, 549	269, 659, 537

STATISTICAL TABLES

Tables 3 to 13 analyze the Department's budget for the fiscal years 1937 and 1938 and contain data relative to emergency and other special funds for these and prior years.

Table 3 summarizes the regular and emergency funds provided for the entire fiscal year 1937 and regular funds for 1938 (as of September 1, 1937). Since at the time of preparing this report (October 11) only 3 months of the fiscal year 1938 had elapsed, it was impracticable to forecast allocations from emergency funds for the entire year, and hence no allocations for that year from such funds are included in table 3.

Table 4 indicates the source of regular appropriations for 1937 and 1938; table 5 is a summary, classified by groups and bureau units, of the regular appropriations for 1937 and 1938 (as of September 1) and of obligations incurred during 1937 (as of June 30); and table 6 gives the same information in greater detail.

Table 7 lists all the funds made available to the Agricultural Adjustment Administration since the passage of the Agricultural Adjustment Act of May 12, 1933, covering the fiscal years 1933 to 1938, inclusive (as of September 1); and table 8 shows in detail, by fiscal years, the obligations incurred through June 30, 1937, under these funds.

Table 9 classifies the total obligations incurred under regular funds during the fiscal year 1937 by types of activity (research, extension, regulatory work, etc.); and table 10 indicates, by bureaus, the amounts allocated to research work (obligations for the fiscal year 1937 and estimated allotments for 1938).

Table 11 contains a summary of all emergency funds appropriated or allocated to the Department for the period from 1931 to 1937, inclusive; and table 12 gives the same information in detail, together with amounts obligated under emergency funds during each fiscal year involved.

Table 13 is a separate detailed analysis of funds allocated during 1935, 1936, and 1937 under the Emergency Relief Appropriation Acts of 1935 and 1936 and the obligations thereunder. In each case the year of allocation is determined by the date of the Treasury warrant transferring the funds.

TABLE 3.—*Summary of Department of Agriculture funds provided during the fiscal years 1937 and 1938 (as of Sept. 1, 1937)*

[For more detailed statement of Department funds see subsequent tables]

Item	Appropriation, 1937 [1]	Appropriation, 1938 [2]
Regular appropriations:		
Agricultural Adjustment Administration	[3] $549,139,621	[3] $465,347,214
Bankhead-Jones Farm Tenant Act		20,000,000
Soil Conservation Service	24,869,265	24,390,780
Payments to States for agricultural experiment stations, extension work, and special forestry activities	24,470,600	25,448,169
Road construction	68,000,000	180,000,000
All other objects	64,189,319	65,322,324
Total, regular appropriations	730,668,805	780,508,487
Emergency fund allocations:		
National Industrial Recovery Act:		
Road funds	300,000	(4)
Other	28,600	(4)
Emergency Appropriation Act, 1935	[5] 50,000	(4)
Emergency Relief Appropriation Act of 1935:		
Resettlement Administration	6,890,063	(4)
All other	382,206	(4)
Emergency Relief Appropriation Act of 1936:		
Resettlement Administration	197,995,581	(4)
Road funds	9,914,271	(4)
All other	42,787,828	(4)
Total, emergency fund allocations	258,348,549	(4)
Grand total	989,017,354	[6] 780,508,487

[1] Revised figures; includes all funds actually appropriated or allocated during fiscal year 1937, but excludes balances brought over from prior-year appropriations or allocations.

[2] Includes only regular funds provided for fiscal year 1938, as of Sept. 1, 1937; excludes all emergency-fund allocations for 1938, since amounts for entire fiscal year cannot be predicted; figures for complete fiscal year 1938 will be included in the 1938 report.

[3] In addition, $30,000,000 was made available in 1937 and $160,000,000 in 1938 by transfer from unexpended balances of prior-year and other Agricultural Adjustment Administration funds for carrying out programs under the Soil Conservation and Domestic Allotment Act of Feb. 29, 1936.

[4] See note 2, above.

[5] For construction of feed mill and granary at Beltsville, Md.

[6] Exclusive of emergency fund allocations. (See note 2.)

TABLE 4.—*Source of regular appropriations of the Department of Agriculture, fiscal years 1937 and 1938 (as of Sept. 1, 1937)*

Source	Appropriation, 1937 (revised)	Appropriation, 1938
Agricultural Appropriation Act:		
Department proper	[1] $170,040,606	[1] $286,856,208
Agricultural Adjustment Administration		[2] 340,000,000
Independent Offices Appropriation Act, 1937 (conservation and use of agricultural land resources—Agricultural Adjustment Administration)	440,000,000	
Sec. 32, act of Aug. 24, 1935 (exportation and domestic consumption of agricultural commodities—Agricultural Adjustment Administration)	109,139,621	125,097,214
First Deficiency Appropriation Act, 1936: Weather Bureau station, Lynchburg, Va	12,000	
First Deficiency Appropriation Act, 1937:		
Fighting forest fires (deficiency)	2,045,000	
Enforcement of Commodity Exchange Act	100,000	
Act of June 24, 1936 (Pub. Res. 127, 74th Cong.): Grasshopper control	250,000	
Control of incipient or emergency outbreaks of plant pests:		
Act of Apr. 27, 1937 (Pub. Res. 26, 75th Cong.)	1,000,000	
Act of July 17, 1937 (Pub. Res. 55, 75th Cong.)		1,000,000
Third Deficiency Appropriation Act, 1937:		
Dry-land agriculture investigations (Woodward, Okla., station)		76,000
Bankhead-Jones Farm Tenant Act		20,000,000
Administration of Sugar Act of 1937 (Agricultural Adjustment Administration)		250,000
Permanent annual and indefinite appropriations:		
Cooperative agricultural extension work (Smith-Lever Act)	4,696,096	4,701,165
Payments to States and Territories (national-forest fund)	995,891	1,100,000
Payments to school funds, Arizona and New Mexico (national-forest fund)	31,685	20,000
Roads and trails for States (national-forest fund)	350,000	400,000
Cooperative work, Forest Service (contributed funds)	2,000,000	1,000,000
Payments to counties under Migratory Bird Conservation Act	7,906	7,900
Total, permanent and indefinite	8,081,578	7,229,065
Total, regular funds	730,668,805	780,508,487

[1] Includes $125,000 advanced from Treasury for migratory-bird conservation fund, to be reimbused from hunting-stamp sales receipts, and $475,000 additional from receipts over advances (estimated).
[2] Conservation and use of agricultural land resources, Department of Agriculture.

TABLE 5.—*Summary of regular Department of Agriculture funds, classified by group and bureau units, fiscal years 1937 and 1938*

[For details, see tables 6 and 8]

Activity	Appropriation, 1937	Obligations, 1937 [1]	Appropriation, 1938 [2]
Ordinary activities:			
Office of the Secretary	$616,019	$589,216	$591,450
Office of the Solicitor	188,801	188,329	194,160
Office of Information	1,217,532	1,213,970	1,254,130
Library	103,800	103,300	105,420
Office of Experiment Stations	231,046	229,670	231,046
Special Research Fund, Department of Agriculture	800,000	778,529	1,200,000
Extension Service	901,754	881,046	901,754
Weather Bureau	3,873,024	3,851,369	4,703,049
Bureau of Animal Industry	10,063,963	[3] 9,827,847	10,373,098
Bureau of Dairy Industry	697,094	671,319	703,694
Bureau of Plant Industry	4,551,206	4,487,198	4,809,127
Forest Service	13,292,919	13,173,577	14,116,596
Bureau of Chemistry and Soils	1,398,272	1,383,356	1,425,431
Bureau of Entomology and Plant Quarantine	4,857,675	4,805,909	5,636,398
Bureau of Biological Survey	1,781,539	1,764,325	1,966,655
Bureau of Agricultural Engineering	438,269	435,234	460,769
Bureau of Agricultural Economics	5,992,896	5,833,557	6,212,698
Bureau of Home Economics	219,085	217,985	245,085
Commodity Exchange Administration	296,500	241,882	500,000
Food and Drug Administration	2,077,758	2,070,136	2,227,758
Soil Conservation Service	24,869,265	24,190,988	24,390,780
Beltsville Agricultural Research Center	75,000	74,700	75,000
Total	78,543,417	77,013,442	82,324,098

See footnotes at end of table.

TABLE 5.—*Summary of regular Department of Agriculture funds, classified by group and bureau units, fiscal years 1937 and 1938*—Continued

Activity	Appropriation, 1937	Obligations, 1937	Appropriation, 1938
Special items:			
Forest-fire deficiency (Forest Service)	$2,045,000	$1,816,521	
Acquisition of lands for national forests (Forest Service)	2,500,000	2,459,194	$3,000,000
Plains shelterbelt project (Forest Service)	170,000		
Acquisition of lands for migratory-bird conservation refuges (Bureau of Biological Survey)	36,185	32,821	36,185
Acquisition of lands for Upper Mississippi River Refuge (Bureau of Biological Survey)	18,500	10,802	
Migratory-bird conservation fund (Bureau of Biological Survey)	600,000	466,821	600,000
Sugar laboratory (Bureau of Plant Industry)			99,921
Screwworm control (Bureau of Entomology and Plant Quarantine)	460,000	357,388	75,000
Grasshopper control (Bureau of Entomology and Plant Quarantine)	250,000	20,100	
Control of incipient and emergency outbreaks of plant pests (Bureau of Entomology and Plant Quarantine)	1,000,000	579,400	1,000,000
Total	7,079,685	5,743,047	4,811,106
Receipts and contributed funds	3,435,482	2,582,622	2,577,900
Payments to States (exclusive of road funds and forest-receipt funds):			
State agricultural experiment stations for research (Office of Experiment Stations)	5,620,000	5,620,000	6,232,500
State colleges of agriculture for extension work (Extension Service)	17,125,014	16,981,014	17,490,083
Forest-fire cooperation (Forest Service)	1,655,007	1,647,245	1,655,007
Cooperative distribution of forest planting stock (Forest Service)	70,579	69,723	70,579
Total	24,470,600	24,317,982	25,448,169
Total, all foregoing items	113,529,184	109,657,093	115,161,273
Road funds (regular):			
Federal aid (rural post roads)		[4] 378,171	
Federal-aid highway system	[5] 60,000,000	[6] 125,000,000	[5] 150,000,000
Federal-aid secondary or feeder roads		[6] 25,000,000	[5] 5,000,000
Elimination of grade crossings		[6] 50,000,000	[5] 10,000,000
Public-lands highways		[6] 2,500,000	[5] 2,500,000
Forest roads and trails	[5] 8,000,000	[6] 14,000,000	[5] 12,500,000
Total	68,000,000	216,878,171	180,000,000
Agricultural Adjustment Administration: [3]			
Conservation and use of agricultural land resources:			
Direct appropriation	440,000,000	390,937,938	340,000,000
Reappropriation—Payments for Agricultural Adjustment, Supplemental Appropriation Act, fiscal year 1936	30,000,000		
Reappropriation—1937 funds made available by sec. 32, act of Aug. 24, 1935			93,796,936
Transfer from 1938 funds under sec. 32, act of Aug. 24, 1935			16,203,064
Allotment from unexpended balance of funds provided by sec. 12a, act of May 12, 1933			50,000,000
Total	470,000,000	390,937,938	500,000,000
Exportation and domestic consumption of agricultural commodities (sec. 32, act of Aug. 24, 1935)	109,139,621	25,775,125	[7] 108,894,150
Sugar Act of 1937 (Sept. 1, 1937)			250,000
Obligations under prior-year appropriations and allocations [3]		100,251,693	
Total [3]	579,139,621	516,964,756	609,144,150
Elimination of diseased cattle:			
Bureau of Animal Industry (eradication of bovine tuberculosis and Bang's disease)	[8] 16,864,000	16,525,537	[8] 15,864,000
Agricultural Adjustment Administration (removal of surplus dairy products)	[8] 7,500,000	3,578,348	
Total	24,364,000	20,103,885	15,864,000

See footnotes at end of table.

TABLE 5.—*Summary of regular Department of Agriculture funds, classified by group and bureau units, fiscal years 1937 and 1938*—Continued

Activity	Appropriation, 1937	Obligations, 1937	Appropriation, 1938
Bankhead-Jones Farm Tenant Act:			
Resettlement Administration: Farm tenancy (title I)			$10,000,000
Bureau of Agricultural Economics: Land utilization and retirement of submarginal lands (title III)			10,000,000
Total			20,000,000
Deduct reappropriations included in the foregoing:			
Conservation and use of agricultural land resources (Agricultural Adjustment Administration)	−$30,000,000		−143,796,936
Elimination of diseased cattle	−24,364,000		−15,864,000
Total reappropriations	−54,364,000		−159,660,936
Grand total	730,668,805	$863,603,905	780,508,487

[1] As of June 30, 1937.
[2] As of Sept. 1, 1937.
[3] Exclusive of elimination of diseased cattle.
[4] Obligated for highway research out of prior-year appropriations.
[5] Actual appropriations for fiscal years indicated.
[6] 1938 authorizations obligated in 1937 (act of June 16, 1936).
[7] Excludes $16,203,064 transferred to conservation and use of agricultural land resources.
[8] Reappropriations from unobligated balances of appropriations provided by the Jones-Connally Act (Apr. 7, 1934, and May 25, 1934) and sec. 37, act of Aug. 24, 1935.

TABLE 6.—*Detailed statement, by bureaus and appropriation items, of regular Department of Agriculture funds, fiscal years 1937 and 1938*

Bureau and item	Appropriation, 1937 (revised)	Obligations, 1937 [1]	Appropriation, 1938 [2]
Ordinary activities:			
Office of the Secretary:			
Salaries	$432,271	$431,566	$452,700
Miscellaneous expenses	120,748	95,100	[3] 105,750
Rent of buildings in District of Columbia	63,000	62,550	33,000
Total	616,019	589,216	591,450
Office of the Solicitor: Salaries and expenses	188,801	188,329	194,160
Office of Information:			
Salaries and expenses	363,282	359,720	366,480
Printing and binding	854,250	854,250	887,650
Total	1,217,532	1,213,970	1,254,130
Library: Salaries and expenses	103,800	103,300	105,420
Office of Experiment Stations:			
Administration of grants to States and coordination of research	161,735	160,697	161,735
Insular experiment stations:			
Hawaii	12,066	12,023	2,066
Puerto Rico	57,245	56,950	67,245
Total	231,046	229,670	231,046
Special Research Fund, Department of Agriculture	800,000	778,529	1,200,000
Extension Service:			
General administrative expenses	126,246	121,117	126,246
Farmers' cooperative demonstration work	554,670	542,010	554,670
Motion pictures	79,000	77,245	79,000
Agricultural exhibits at fairs	85,000	84,500	85,000
Cooperative farm forestry (Clarke-McNary Act)	56,838	56,174	56,838
Total	901,754	881,046	901,754

See footnotes at end of table.

TABLE 6.—*Detailed statement, by bureaus and appropriation items, of regular Department of Agriculture funds, fiscal years 1937 and 1938*—Continued

Bureau and item	Appropriation, 1937 (revised)	Obligations, 1937	Appropriation, 1938
Ordinary activities—Continued.			
Weather Bureau:			
General administrative expenses	$138,280	$138,046	$170,000
General weather service and research	[4] 2,240,655	2,228,767	2,342,870
Aerology	1,494,089	1,484,556	2,190,179
Total	3,873,024	3,851,369	4,703,049
Bureau of Animal Industry:			
General administrative expenses	178,220	174,273	178,220
Animal husbandry	769,503	746,986	789,380
Diseases of animals	437,775	418,553	447,775
Eradicating tuberculosis:			
Administrative and operating expenses	1,103,116	1,058,225	1,103,116
Payment of indemnities	396,884	371,289	499,884
Eradicating cattle ticks	513,940	497,648	513,940
Eradicating dourine	8,613	4,369	(5)
Hog cholera control	127,192	119,194	127,192
Inspection and quarantine	669,935	661,700	680,000
Meat inspection	5,258,194	5,197,972	5,433,000
Virus-Serum-Toxin Act	218,712	215,284	218,712
Packers and Stockyards Act	381,879	362,354	381,879
Total	10,063,963	[6] 9,827,847	10,373,098
Bureau of Dairy Industry:			
General administrative expenses	67,995	67,923	70,495
Dairy investigations	629,099	603,396	633,199
Total	697,094	671,319	703,694
Bureau of Plant Industry:			
General administrative expenses	189,242	186,991	189,242
Arlington farm	49,414	49,085	49,414
Botany	76,635	74,563	76,635
Cereal crops and diseases	520,721	516,244	541,721
Cotton and other fiber crops and diseases	406,435	396,921	406,435
Drug and related plants	47,139	45,759	47,139
Dry-land agriculture	215,578	214,157	[7] 291,578
Experimental greenhouse maintenance	78,632	78,092	78,632
Forage crops and diseases	300,193	294,644	300,193
Forest pathology	252,092	247,627	259,592
Fruit and vegetable crops and diseases	1,140,454	1,128,100	1,179,482
Genetics and biophysics	31,675	31,134	31,675
Myocology and disease survey	45,818	45,479	45,818
National Aboretum	34,307	34,091	122,000
Nematology	43,961	43,308	48,961
Plant exploration and introduction	204,483	203,285	204,483
Plant nutrition	16,024	15,838	16,024
Rubber and other tropical plants	46,749	46,444	46,749
Seed investigations	67,293	66,033	72,293
Soil-fertility investigations	172,157	165,674	172,157
Soil-microbiology investigations	39,854	39,298	39,854
Sugar-plant investigations	312,079	309,170	[8] 328,779
Tobacco investigations	137,744	133,787	137,744
Western irrigation agriculture	122,527	121,474	122,527
Total	4,551,206	4,487,198	4,809,127
Forest Service:			
General administrative expenses	565,232	565,232	607,500
National forest administration	10,815,950	10,704,585	11,425,950
Water rights	10,000	8,992	10,000
Fighting forest fires	100,000	100,000	100,000
Forest management	620,994	618,625	638,403
Range investigations	181,935	181,082	225,935
Forest products	608,361	606,259	628,361
Forest survey	200,000	199,471	220,000
Forest economics	91,295	90,667	121,295
Forest influences	99,152	98,664	139,152
Total	13,292,919	13,173,577	14,116,596

See footnotes at end of table.

TABLE 6.—*Detailed statement, by bureaus and appropriation items, of regular Department of Agriculture funds, fiscal years 1937 and 1938*—Continued

Bureau and item	Appropriation, 1937 (revised)	Obligations, 1937	Appropriation, 1938
Ordinary activities—Continued.			
Bureau of Chemistry and Soils:			
General administrative expenses	$90,241	$89,631	$90,241
Agricultural chemical investigations	360,260	358,946	360,260
Industrial utilization of farm products and byproducts	171,243	169,553	196,243
Agricultural fires and explosive dusts	48,403	45,546	48,403
Naval-stores investigations	79,241	78,610	81,400
Soil survey	301,208	295,606	301,208
Soil chemical and physical investigations	78,081	77,890	78,081
Fertilizer investigations	269,595	267,574	269,595
Total	1,398,272	1,383,356	1,425,431
Bureau of Entomology and Plant Quarantine:			
General administrative expenses	162,288	162,100	166,280
Fruit insects	[9] 391,631	379,169	428,600
Japanese-beetle control	350,000	348,039	425,000
Mexican-fruitfly control	140,460	135,868	160,460
Citrus canker eradication	13,485	13,438	13,485
Sweetpotato-weevil control			75,000
Phony peach and peach-mosaic eradication	[10] 49,828	49,790	89,800
Forest insects	[11] 169,125	168,547	253,100
Gypsy and brown-tail moth control	400,000	398,136	400,000
Blister-rust control	250,000	246,303	300,000
Dutch-elm disease eradication	261,156	249,758	460,860
Truck-crop and garden insects	366,418	364,032	381,580
Cereal and forage insects	[12] 364,329	360,480	364,329
European corn-borer control	32,939	32,812	32,939
Barberry eradication	200,000	199,171	200,000
Cotton insects	[13] 144,544	144,135	144,544
Pink-bollworm control	276,839	275,785	296,800
Thurberia-weevil control	2,808	2,800	2,808
Bee culture	75,500	74,906	83,000
Insects affecting man and animals	150,148	149,388	182,600
Insect-pest survey and identification	[14] 129,798	129,714	159,790
Foreign parasites	[15] 28,000	27,673	38,000
Control investigations	62,518	62,061	62,518
Fumigation investigations			10,000
Insecticide and fungicide investigations	148,984	145,500	148,984
Transit inspection	29,059	29,012	44,059
Foreign-plant quarantine	625,956	625,498	680,000
Certification of exports	31,862	31,800	31,862
Total	4,857,675	4,805,909	5,636,398
Bureau of Biological Survey:			
General administrative expenses	95,000	94,900	110,000
Food habits of birds and animals	60,640	60,029	68,140
Fur-resources investigations [16]	77,612	77,468	66,000
Biological investigations	138,149	136,637	171,149
Control of predatory animals and injurious rodents	600,000	594,601	612,000
Protection of migratory birds	300,000	295,586	315,000
Enforcement of Alaska game law	130,798	129,937	130,798
Maintenance of mammal and bird reservations	335,772	332,504	450,000
Migratory bird conservation refuges (maintenance, operation, and research)	[17] 43,568	42,663	[17] 43,568
Total	1,781,539	1,764,325	1,966,655
Bureau of Agricultural Engineering:			
General administrative expenses	37,600	37,570	37,600
Agricultural engineering investigations	400,669	397,664	423,169
Total	438,269	435,234	460,769
Bureau of Agricultural Economics:			
General administrative expenses	236,306	236,042	236,306
Farm management and practice	356,580	330,791	376,580
Marketing and distributing farm products	756,154	740,380	808,650
Crop and livestock estimates	686,289	676,289	686,289
Foreign competition and demand	298,000	284,623	298,000
Market inspection of farm products	378,533	373,735	426,500
Tobacco Inspection Act	250,000	229,952	275,000
Market news service	1,062,057	1,057,304	1,077,000
Perishable Agricultural Commodities Act	137,666	135,934	143,890

See footnotes at end of table.

TABLE 6.—*Detailed statement, by bureaus and appropriation items, of regular Department of Agriculture funds, fiscal years 1937 and 1938*—Continued

Bureau and item	Appropriation, 1937 (revised)	Obligations, 1937	Appropriation, 1938
Ordinary activities—Continued.			
Bureau of Agricultural Economics—Continued.			
Standard Container, Hamper, and Produce Agency Acts	$30, 238	$29, 447	$36, 238
Peanut stocks and standards			16, 000
Tobacco stocks and standards	17, 187	16, 374	17, 187
Cotton grade and staple statistics	224, 517	223, 935	224, 517
Cotton Futures and Cotton Standards Acts	487, 111	447, 112	501, 900
Grain Standards Act	723, 941	714, 051	723, 941
Warehouse Act	321, 665	311, 387	326, 700
Wool marketing studies	26, 652	26, 201	50, 000
Total	5, 992, 896	5, 833, 557	6, 212, 698
Bureau of Home Economics:			
General administrative expenses	31, 735	31, 535	31, 735
Home economics investigations	187, 350	186, 450	213, 350
Total	219, 085	217, 985	245, 085
Commodity Exchange Administration: Enforcement of the Commodity Exchange Act [15]	[19] 296, 500	241, 882	500, 000
Food and Drug Administration:			
General administrative expenses	100, 802	100, 498	100, 802
Enforcement of Food and Drugs Act	1, 600, 000	1, 594, 877	1, 750, 000
Enforcement of Tea Importation Act	40, 094	39, 836	40, 094
Naval Stores Act	34, 700	34, 038	34, 700
Enforcement of Insecticide Act	208, 180	207, 350	208, 180
Enforcement of Milk Importation Act	19, 241	18, 948	19, 241
Enforcement of Caustic Poison Act	24, 741	24, 625	24, 741
Enforcement of Filled Milk Act	10, 000	9, 964	10, 000
Enforcement of Sea Food Inspectors Act	40, 000	40, 000	40, 000
Total	2, 077, 758	2, 070, 136	2, 227, 758
Soil Conservation Service:			
General administrative expenses	475, 000	465, 358	675, 000
Soil and moisture conservation and land-use investigations	1, 540, 780	1, 511, 118	1, 540, 780
Soil and moisture conservation operations, demonstrations, and information	22, 853, 485	22, 214, 512	22, 175, 000
Total	24, 869, 265	24, 190, 988	24, 390, 780
Beltsville Agricultural Research Center	75, 000	74, 700	75, 000
Total, ordinary activities	78, 543, 417	77, 013, 442	82, 324, 098
Special items:			
Forest-fire deficiency (Forest Service)	[20] 2, 045, 000	1, 816, 521	
Acquisition of lands for national forests (Forest Service)	2, 500, 000	2, 459, 194	3, 000, 000
Plains shelterbelt project (Forest Service)	170, 000		
Acquisition of lands for migratory-bird conservation refuges (Bureau of Biological Survey)	36, 185	32, 821	36, 185
Acquisition of lands for Upper Mississippi River Refuge (Bureau of Biological Survey)	18, 500	10, 802	
Migratory bird conservation fund (Bureau of Biological Survey)	[21] 600, 000	466, 821	[21] 600, 000
Sugar laboratory at Houma, La. (Bureau of Plant Industry)			99, 921
Screwworm control (Bureau of Entomology and Plant Quarantine)	460, 000	357, 388	75, 000
Grasshopper control (Bureau of Entomology and Plant Quarantine)	[22] 250, 000	20, 100	
Control of incipient and emergency outbreaks of plant pests (Bureau of Entomology and Plant Quarantine)	[23] 1, 000, 000	579, 400	[24] 1, 000, 000
Total, special items	7, 079, 685	5, 743, 047	4, 811, 106

See footnotes at end of table.

TABLE 6.—*Detailed statement, by bureaus and appropriation items, of regular Department of Agriculture funds, fiscal years 1937 and 1938*—Continued

Bureau and item	Appropriation, 1937 (revised)	Obligations, 1937	Appropriation, 1938
Receipts and contributed funds:			
Forest Service:			
Acquisition of lands in Uintah and Wasatch National Forests	$50,000	$47,620	$50,000
Payments to States and Territories	995,891	995,891	1,100,000
Payments to school funds, Arizona and New Mexico	31,685	31,685	20,000
Roads and trails for States	350,000	[25] 427,599	400,000
Cooperative work (contributed funds)	2,000,000	1,071,921	1,000,000
Bureau of Biological Survey: Payments to counties under Migratory Bird Conservation Act	7,906	7,906	7,900
Total receipts and contributed funds	3,435,482	2,582,622	2,577,900
Payments to States (exclusive of road funds and forest-receipts funds):			
Office of Experiment Stations (for research work of State agricultural experiment stations):			
Hatch Act	720,000	720,000	720,000
Adams Act	720,000	720,000	720,000
Purnell Act	2,880,000	2,880,000	2,880,000
Hawaii	50,000	50,000	50,000
Alaska	15,000	15,000	22,500
Puerto Rico	35,000	35,000	40,000
Title I, Bankhead-Jones Act	1,200,000	1,200,000	1,800,000
Total	5,620,000	5,620,000	6,232,500
Extension Service (for extension work of State agricultural colleges):			
Smith-Lever Act (permanent annual)	4,696,096	4,692,096	4,701,165
Supplementary cooperative extension work (Smith-Lever Act)	1,185,000	1,185,000	790,000
Capper-Ketcham extension work	1,480,000	1,480,000	1,480,000
Extension work, section 21, Bankhead-Jones Act	9,000,000	8,860,000	10,000,000
Alaska	13,918	13,918	18,918
Additional cooperative extension work	750,000	750,000	500,000
Total	17,125,014	16,981,014	17,490,083
Forest Service:			
Forest-fire cooperation	1,655,007	1,647,245	1,655,007
Cooperative distribution of forest planting stock	70,579	69,723	70,579
Total	1,725,586	1,716,968	1,725,586
Total, payments to States	24,470,600	24,317,982	25,448,169
Total, all foregoing items	113,529,184	109,657,093	115,161,273
Road funds (regular):			
Federal aid (rural post roads)	----------	[26] 378,171	----------
Federal-aid highway system	[27] 60,000,000	[28] 125,000,000	[27] 150,000,000
Federal-aid secondary or feeder roads	----------	[28] 25,000,000	[27] 5,000,000
Elimination of grade crossings	----------	[28] 50,000,000	[27] 10,000,000
Public-lands highways	----------	[28] 2,500,000	[27] 2,500,000
Forest roads and trails	[27] 8,000,000	[28] 14,000,000	[27] 12,500,000
Total, road funds (regular)	68,000,000	216,878,171	180,000,000
Agricultural Adjustment Administration: [29]			
Conservation and use of agricultural land resources	[30] 440,000,000	390,937,938	[31] 340,000,000
Exportation and domestic consumption of agricultural commodities (sec. 32, act of Aug. 24, 1935)	109,139,621	25,775,125	125,097,214
Sugar Act of 1937	----------	----------	[32] 250,000
Obligations under prior-year appropriations and allocations [29]	----------	100,251,693	----------
Total, Agricultural Adjustment Administration [29]	549,139,621	[33] 516,964,756	465,347,214

TABLE 6.—*Detailed statement, by bureaus and appropriation items, of regular Department of Agriculture funds, fiscal years 1937 and 1938*—Continued

Bureau and item	Appropriation, 1937 (revised)	Obligations, 1937	Appropriation, 1938
Elimination of diseased cattle (payable from reappropriations of unexpended balances of funds provided by sec. 37 of the act of Aug. 24, 1935, and by Jones-Connally Act for elimination of diseased dairy and beef cattle and disposition of surplus agricultural products):			
Bureau of Animal Industry:			
Eradicating tuberculosis in cattle		$2,741,876	
Combating Bang's disease in cattle		13,681,634	
Experimentation in diseases of livestock		102,027	
Agricultural Adjustment Administration: Removal of surplus agricultural products (purchase of dairy products)		3,578,348	
Total, elimination of diseased cattle		20,103,885	
Bankhead-Jones Farm Tenant Act:			
Resettlement Administration: Farm tenancy (title I)			[32] $10,000,000
Bureau of Agricultural Economics: Land utilization and retirement of submarginal land (title III)			[32] 10,000,000
Total, Bankhead-Jones Farm Tenant Act			20,000,000
Grand total, regular funds	$730,668,805	863,603,905	780,508,487

[1] As of June 30, 1937.
[2] As of Sept. 1, 1937.
[3] In addition, $10,000 of unexpended balance of 1937 appropriation made available for expenses of moving into South Building.
[4] Includes $12,000 provided by First Deficiency Appropriation Act, 1936, for Weather Bureau station at Lynchburg, Va.
[5] Combined with appropriation Inspection and quarantine in 1938 Agricultural Appropriation Act.
[6] Exclusive of Elimination of diseased cattle.
[7] Includes $76,000 provided for 1938 by Third Deficiency Appropriation Act, 1937, for Woodward (Okla.) field station.
[8] Exclusive of $99,921 for sugar laboratory, Houma, La., shown under Special items.
[9] Excludes $7,900 allotted to Foreign parasites.
[10] Appropriation limited to phony peach eradication in fiscal year 1937.
[11] Excludes $1,500 allotted to Foreign parasites.
[12] Excludes $7,900 allotted to Foreign parasites.
[13] Excludes $2,700 allotted to Foreign parasites.
[14] Excludes $5,000 allotted to Foreign parasites.
[15] Allotted from other items, as indicated by notes 9, 11, 12, 13, and 14; set up as new item in 1938 Agricultural Appropriation Act.
[16] Appropriation title changed from Production of fur-bearing animals in 1938 Agricultural Appropriation Act.
[17] For land acquisition under this appropriation, see Special items.
[18] Appropriation title changed from Enforcement of the Grain Futures Act in 1938 Agricultural Appropriation Act.
[19] Includes $100,000 provided by First Deficiency Appropriation Act, 1937, for administering this law.
[20] Provided by First Deficiency Appropriation Act, 1937.
[21] Estimated receipts from sale of hunting stamps; includes $125,000 advanced from Treasury by Agricultural Appropriation Act, to be reimbursed from hunting-stamp receipts.
[22] Provided by act of June 24, 1936 (Pub. Res. 127, 74th Cong.); $225,800 obligated under immediately available authority in 1936.
[23] Provided by act of Apr. 27, 1937 (Pub. Res. 26, 75th Cong.); available until June 30, 1938.
[24] Provided by act of July 17, 1937 (Pub. Res. 55, 75th Cong.); available until June 30, 1938.
[25] Consists of 10 percent of national-forest receipts accruing during fiscal year 1936; obligations in excess of estimates.
[26] Obligated for highway research out of prior-year appropriations.
[27] These are the amounts actually appropriated during the fiscal years indicated.
[28] Authorized by the act of June 16, 1936, to be appropriated for the fiscal year 1938, but apportioned to States for obligation in 1937, as provided by said act.
[29] Exclusive of Elimination of diseased cattle.
[30] In addition, $30,000,000 was made available from funds provided for Payments for Agricultural Adjustment in Supplemental Appropriation Act, fiscal year 1936.
[31] In addition, $110,000,000 was made available from funds for 1937 and 1938 under sec. 32 of the act of Aug. 24, 1935, and $50,000,000 from the unexpended balance of the $100,000,000 provided by sec. 12 (a) of the Agricultural Adjustment Act of May 12, 1933.
[32] Provided for 1938 by Third Deficiency Appropriation Act, fiscal year 1937.
[33] For details, see table 8.

TABLE 7.—*Funds available to the Agricultural Adjustment Administration, fiscal years 1933 to 1938, inclusive (as of Sept. 1, 1937)*

[For obligations hereunder, 1933–37, see table 8]

Appropriation or allocation	1933	1934	1935	1936	1937	1938	Total
Agricultural Adjustment Act, of May 12, 1933, as amended:							
Salaries and expenses (sec. 12a)	[1] $100,000,000						$100,000,000
Advances to Agricultural Adjustment Administration (sec. 12b)		$428,580,320	$640,718,602	$165,259,343			1,234,558,265
Purchase of surplus sugar (sec. 17d of Jones-Costigan Act of May 9, 1934, amending sec. 16 of Agricultural Adjustment Act)			365,536	110,952			476,488
Total	100,000,000	428,580,320	641,084,138	165,370,295			1,335,034,753
Tobacco Act of June 28, 1934			433,886	352,706			786,592
Jones-Connally Act (acts of Apr. 7, 1934, and May 25, 1934)			150,000,000				150,000,000
Supplemental Appropriation Act, 1936 (payments for agricultural adjustment)				[2] 295,731,900			295,731,900
Sec. 32 of act of Aug. 24, 1935 (exportation and domestic consumption of agricultural commodities)				92,111,741	$109,139,621	$125,097,214	326,348,576
National Industrial Recovery Act (June 16, 1933)		37,495,227					37,495,227
Emergency Appropriation Act, 1935 (loans and relief in stricken agricultural areas)			80,743,351				80,743,351
Conservation and use of agricultural land resources:							
Sec. 2, Independent Offices Appropriation Act, 1937					[3] 440,000,000		440,000,000
Agricultural Appropriation Act, 1938						[4] 340,000,000	340,000,000
Act of May 9, 1934 (Puerto Rico trust fund from sugar processing taxes)				1,552,104			1,552,104
Sugar Act of 1937 (Sept. 1, 1937)						250,000	250,000
Grand total	100,000,000	466,075,547	872,261,375	555,118,746	549,139,621	465,347,214	3,007,942,503

[1] Available until expended.

[2] Exclusive of $453,100 (of total appropriation of $296,185,000) returned to surplus, pursuant to sec. 2 of act of Mar. 14, 1936 (Pub. Res. 76, 74th Cong.).

[3] Provided for fiscal year 1937 by sec. 2 of Independent Offices Appropriation Act, 1937, together with $30,000,000 additional for this purpose by transfer from the $296,185,000 appropriation for Payments for Agricultural Adjustment provided by the Supplemental Appropriation Act, 1936; funds made immediately available in 1936.

[4] In addition, $110,000,000 of 1937 and 1938 funds under sec. 32 of the act of Aug. 24, 1935, and $50,000,000 of the unexpended balance of the $100,000,000 appropriation provided under sec. 12a of the Agricultural Adjustment Act were made available for this purpose in 1938.

TABLE 8.—*Obligations incurred under funds available to the Agricultural Adjustment Administration, fiscal years 1933 to 1937, inclusive (as of June 30, 1937)*

[For appropriations see table 7]

Appropriation and item	1933	1934	1935	1936	1937 (estimated)	Total obligations, 1933–37 [1]
Agricultural Adjustment Act of May 12, 1933, as amended:						
Salaries and expenses (sec. 12a):						
Agricultural Adjustment Administration	$17,374	$2,501,784	$4,538,344	$3,931,986	$4,308,669	$15,298,157
Office of the Secretary			228,854	353,026	25,000	606,880
Office of the Solicitor			143,868	451,955	268,217	864,040
Office of Information			2,454	14,490		16,944
Library		648	1,317	4,128	3,240	9,333
Extension Service		6,516	14,000	8,400	18,040	46,956
Bureau of Animal Industry				975	18,208	19,183
Bureau of Plant Industry		1,832				1,832
Bureau of Chemistry and Soils					13,540	13,540
Bureau of Agricultural Economics		47,226	117,553	213,786	95,097	473,662
Bureau of Home Economics			1,986			1,986
Federal Trade Commission		5,000				5,000
Bureau of Census, Department of Commerce				6,463		6,463
Department of Justice				71,419	5,100	76,519
Bureau of Labor Statistics, Department of Labor		6,024	5,766	4,486		16,276
Treasury Department				3,000,000	12,500	3,012,500
Division of Disbursement, Treasury Department		1,404				1,404
International Wheat Advisory Committee					4,021	4,021
Agricultural payments to cotton ginners					2,532,350	2,532,350
Tobacco compacts and agreements among States					[1] 511	511
Total	17,374	2,570,434	5,054,142	8,061,114	7,304,493	23,007,557
Advances to Agricultural Adjustment Administration (sec. 12b):						
Agricultural rental and benefit payments		350,838,845	579,722,081	143,034,461		1,073,595,387
Removal of surplus agricultural products		61,057,890				61,057,890
Refunds of taxes (Bureau of Internal Revenue)		1,374,404	32,063,189	9,055,119		42,492,712
Administrative expenses:						
Agricultural Adjustment Administration		3,835,309	8,150,095	3,956,271		15,941,675
Extension Service		7,906,906	7,519,621	3,362,852		18,789,379
Bureau of Animal Industry		115,586				115,586
Bureau of Plant Industry			2,495			2,495
Forest Service			250			250
Bureau of Chemistry and Soils		1,517	915			2,432
Bureau of Entomology and Plant Quarantine		2,874				2,874
Bureau of Agricultural Economics		797,431	672,369	428,221		1,898,021
Bureau of Census, Department of Commerce		841				841
Department of Justice				3,565		3,565

See footnotes at end of table.

TABLE 8.—*Obligations incurred under funds available to the Agricultural Adjustment Administration, fiscal years 1933 to 1937, inclusive (as of June 30, 1937)*—Continued

Appropriation and item	1933	1934	1935	1936	1937 (estimated)	Total obligations, 1933–37
Agricultural Adjustment Act of May 12, 1933, as amended—Continued.						
Advances to Agricultural Adjustment Administration—Continued.						
Administrative expenses—Continued.						
Bureau of Internal Revenue, Treasury Department		$2,544,178	$3,746,502	$1,966,774		$8,257,454
Office of the Treasurer (Treasury Department)		50,000	100,238	54,358		201,596
Division of Disbursement (Treasury Department)		34,243	699,405	385,752		1,119,400
Customs Service, Treasury Department				7,248		7,248
Administration of Cotton Act of 1934:						
Agricultural Adjustment Administration		17,355	770,847	429,040		1,217,242
Extension Service			6,311,059	2,251,306		8,562,365
Bureau of Agricultural Economics		1,521	60,728			62,249
Bureau of Internal Revenue, Treasury Department		1,420	898,808	324,376		1,224,604
Total		428,580,320	640,718,602	165,259,343		1,234,558,265
Purchases of surplus sugar (sec. 17d of Jones-Costigan Act of May 9, 1934, amending sec. 16 of the Agricultural Adjustment Act)			365,536	110,952		476,488
Total, Agricultural Adjustment Act, as amended	$17,374	431,150,754	646,138,280	173,431,409	$7,304,493	1,258,042,310
Tobacco Act of June 28, 1934:						
Agricultural Adjustment Administration			185,331	151,544		336,875
Extension Service			134,939	137,000		271,939
Bureau of Internal Revenue, Treasury Department			113,616	64,162		177,778
Total			433,886	352,706		786,592
Jones-Connally Act (acts of Apr. 7, 1934, and May 25, 1934):						
Agricultural Adjustment Administration:						
Removal of surplus agricultural products:						
Dairy products			10,490,781	2,176,924		12,667,705
Cattle		797,012	61,490,687			62,287,699
Administrative expenses		62,749	613,119	740,839		1,416,707
Extension Service (assistance in cattle purchase program)				23,000		23,000
Bureau of Animal Industry (assistance in cattle purchase program and elimination of diseased cattle)			21,344,682	19,292,825		40,637,507
Bureau of Agricultural Economics (inspection of milk, butter, and cheese purchased for relief)			26,778	12,906		39,684
Bureau of Home Economics (utilization of dried skim milk for relief)				22,500		22,500
Division of Disbursement, Treasury Department (administrative expenses)		3,263	37,600			40,863
Total		863,024	94,003,647	22,268,994		117,135,665

Elimination of diseased cattle: [2]						
Administrative expenses					106,786	106,786
Removal of surplus agricultural products (purchase of dairy products)					3,466,212	3,466,212
Bureau of Agricultural Economics					368	368
Bureau of Home Economics					4,982	4,982
Total					[3] 3,578,348	3,578,348
Supplemental Appropriation Act, 1936:						
Payments for agricultural adjustment:						
Rental and benefit payments				155,256,050	89,037,472	244,293,522
Removal of agricultural surplus				5,222	89,799	95,021
Administrative expenses (Agricultural Adjustment Administration)				2,829,051	3,535,764	6,364,815
Extension Service				922,475	232,525	1,155,000
Bureau of Agricultural Economics				179,266		179,266
Office of the Treasurer, Treasury Department				25,000		25,000
General Accounting Office					479	479
Payments for administrative expenses under tobacco, cotton, and potato acts:						
Agricultural Adjustment Administration				90,997	16,823	107,820
Office of the Secretary				10,512	5,528	16,040
Extension Service				650,000		650,000
Bureau of Internal Revenue, Treasury Department				64,162		64,162
Redemption of tax payment warrants					20,991	20,991
Administrative expenses, purchase and sale of seed				9,895	7,819	17,714
Total				160,042,630	92,947,200	252,989,830
Sec. 32 of act of Aug. 24, 1935 (exportation and domestic consumption of agricultural commodities):						
Cotton price adjustment:						
Adjustment payments				30,153,034	9,658,066	39,811,100
Administrative expenses:						
Agricultural Adjustment Administration				402,335	210,930	613,265
Extension Service				1,410,000	528,444	1,938,444
General Accounting Office				178,787	25,000	203,787
Office of Treasurer, Treasury Department				26,000		26,000
Division of Disbursement, Treasury Department				34,320	10,000	44,320
Removal of agricultural surpluses				15,811,741	15,342,685	31,154,426
Administrative expenses:						
Agricultural Adjustment Administration				50,489		50,489
Bureau of Internal Revenue, Treasury Department				33,000,000		33,000,000
Total				81,066,706	25,775,125	106,841,831
National Industrial Recovery Act:						
Rental and benefit payments, corn-hog adjustment program (supplementing processing taxes)		12,124,194	24,830,139			36,954,333
Administrative expenses in connection with codes under jurisdiction of the Secretary of Agriculture		250,000	205,119	44,744		499,863
Total		12,374,194	25,035,258	44,744		37,454,196

See footnotes at end of table.

TABLE 8.—*Obligations incurred under funds available to the Agricultural Adjustment Administration, fiscal years 1933 to 1937, inclusive (as of June 30, 1937)*—Continued

Appropriation and item	1933	1934	1935	1936	1937 (estimated)	Total obligations, 1933-37
Emergency Appropriation Act, 1935 (loans and relief in stricken agricultural areas):						
Purchase of seed			$19,179,358			$19,179,358
Purchase and disposition of livestock			57,062,209			57,062,209
Administrative expenses, Agricultural Adjustment Administration			3,146,439			3,146,439
Bureau of Dairy Industry			1,180			1,180
Bureau of Plant Industry			88,303			88,303
Bureau of Agricultural Economics			262,500			262,500
Bureau of Indian Affairs, Interior Department			800,000			800,000
Total			80,539,989			80,539,989
Independent Offices Appropriation Act, 1937 (conservation and use of agricultural land resources):						
Conservation payments					$371,769,475	371,769,475
Administrative expenses, Agricultural Adjustment Administration				$4,505,577	15,457,436	19,963,013
Office of the Secretary					315,288	315,288
Office of the Solicitor					98,160	98,160
Office of Information					13,516	13,516
Extension Service				75,000	1,401,304	1,476,304
Forest Service					470,797	470,797
Bureau of Agricultural Economics				58,081	557,344	615,425
Bureau of Home Economics					7,484	7,484
Soil Conservation Service					8,488	8,488
Bureau of Census, Department of Commerce				1,575		1,575
General Accounting Office					425,046	425,046
Office of the Treasurer, Treasury Department					85,000	85,000
Division of Disbursement, Treasury Department					325,000	325,000
Farm Credit Administration					3,600	3,600
Total				4,640,233	390,937,938	395,578,171
Puerto Rico trust funds (sec. 8 of Jones-Costigan Act of May 9, 1934, amending sec. 15f of Agricultural Adjustment Act):						
Allotment from sugar processing tax collections in Puerto Rico for agricultural rental and benefit payments in connection with adjustment of sugarcane production				1,552,104		1,552,104
Grand total	$17,374	$444,387,972	846,151,060	443,399,526	520,543,104	2,254,499,036

[1] Obligated in 1937 from $300,000 allotment authorized for this purpose for fiscal years 1937 and 1938 by the First Deficiency Appropriation Act, 1936.
[2] Reappropriated by Agricultural Appropriation Act, 1937, from balances of Jones-Connally Act funds and funds made available by sec. 37 of the act of Aug. 24, 1935.
[3] See also Elimination of Diseased Cattle under tables 5 and 6.

TABLE 9.—*Obligations under regular appropriations, fiscal year 1937, classified by types of activity*

Type of activity	All objects except payments to States, road funds, and agricultural adjustment [1]		Payments to States (for experiment stations, extension work, and special forestry activities) [2]	Road funds	Agricultural adjustment	Total	
	Amount	Percent				Amount	Percent
Research	[3] $17,626,876	17.48	[4] $5,620,000	$378,171		$23,625,047	2.74
Extension	1,462,056	1.45	[5] 16,981,014			18,443,070	2.14
Pest control or eradication	[6] 22,528,201	22.33				22,528,201	2.61
Regulatory work	12,266,640	12.16				12,266,640	1.42
Public-service activities	[7] 46,990,035	46.58	[8] 2,707,808			49,697,843	5.74
Road construction				216,500,000		216,500,000	25.07
Agricultural Adjustment Administration					[9] $520,543,104	520,543,104	60.28
Total	100,873,808	100.00	25,308,822	216,878,171	520,543,104	863,603,905	100.00
Percentage of grand total	11.68		2.93	25.11	60.28	100.00	

[1] Includes ordinary activities, special items, and receipts and contributed funds not paid to States.
[2] Exclusive of payments to States from road funds ($200,000,000).
[3] Includes $5,447 from item Migratory-bird conservation fund, $39,070 from Screwworm control, $20,571 from Cooperative work, Forest Service, $44,642 from Forest-fire cooperation, and $102,027 from Elimination of diseased cattle.
[4] Payments to States, Alaska, Hawaii, and Puerto Rico for agricultural experiment stations.
[5] Payments to States, Alaska, Hawaii, and Puerto Rico for cooperative agricultural extension work.
[6] Includes $16,423,510 for eradication of tuberculosis and Bang's disease under item, Elimination of diseased cattle.
[7] Includes $22,679,870 for soil and moisture conservation operations, demonstrations, information, etc.
[8] Consists of payments to States of $1,027,576 from national-forest receipts, $1,602,603 for cooperative forest-fire prevention, and $69,723 for cooperative distribution of forest planting stock, and $7,906 paid to counties under Migratory Bird Conservation Act.
[9] Includes $3,578,348 for disposition of surplus dairy products under item Elimination of diseased cattle.

TABLE 10.—*Department of Agriculture regular funds allocated to research, fiscal years 1937 and 1938*

[For data covering fiscal years 1932–36, see table 7 in 1936 report]

Bureau or activity	1937 (revised)	1938 (estimated)
Weather Bureau	$130,441	$130,760
Bureau of Animal Industry	[1] 1,271,726	[1] 1,389,994
Bureau of Dairy Industry	643,841	674,900
Bureau of Plant Industry	4,459,897	4,876,059
Forest Service	1,859,981	2,068,146
Bureau of Chemistry and Soils	1,383,356	1,425,431
Bureau of Entomology and Plant Quarantine	2,052,995	2,214,335
Bureau of Biological Survey	398,243	412,657
Bureau of Public Roads (highway research paid from regular road funds)	378,171	337,920
Bureau of Agricultural Engineering	404,534	430,069
Bureau of Agricultural Economics	1,407,422	1,553,379
Bureau of Home Economics	217,985	245,085
Food and Drug Administration	129,070	125,484
Soil Conservation Service	1,511,118	1,540,780
Land utilization and retirement of submarginal lands		432,797
Office of Experiment Stations (exclusive of payments to States)	229,670	231,046
Special research fund (Bankhead-Jones Act of June 29, 1935)	778,529	1,200,000
Beltsville agricultural research center	74,700	75,000
General department administration, including pro rata of publication, legal, and library work	673,368	690,945
Total	18,005,047	20,054,787
Payments to State and Territorial experiment stations for research under Hatch, Adams, Purnell, and Bankhead-Jones Acts	5,620,000	6,232,500
Grand total	23,625,047	26,287,287

[1] Includes, for 1937, $102,027, and, for 1938, $150,000, for experimentation in livestock diseases under appropriation Elimination of diseased cattle.

TABLE 11.—*Summary of emergency funds appropriated or allocated to the Department of Agriculture during the fiscal years 1931–37, inclusive (as of June 30, 1937)*

[For detailed obligations hereunder see tables 12 and 13]

Appropriation or allocation	1931	1933	1934	1935	1936	1937	Total
Emergency Construction Act of Dec. 20, 1930 (road funds)	$89,000,000						$89,000,000
First Deficiency Appropriation Act, 1931 (emergency projects)	799,300						799,300
Emergency Relief and Construction Act of July 21, 1932 (road funds)		$132,000,000					132,000,000
National Industrial Recovery Act (June 16, 1933):							
Road funds		400,000,000	$37,380,915	$910,725	$50,000	$300,000	438,641,640
All other			87,711,516	32,644,166	42,127	28,600	120,426,409
Emergency Appropriation Act, 1935 (June 19, 1934):							
Road funds				112,502,239			112,502,239
All other				103,534,705	228,351	50,000	103,813,056
Act of May 9, 1934 (Puerto Rico and Hawaii sugar-tax trust funds)				64,875	1,622,278		1,687,153
Supplemental Appropriation Act, 1936 (payments for Agricultural Adjustment—substitution for Puerto Rico and Hawaii trust funds)					697,951		697,951
Emergency Relief Appropriation Act of 1935 (Apr. 8, 1935):							
Road funds				499,621,865			499,621,865
All other				137,422,944	156,867,703	7,272,269	301,562,916
Emergency Relief Appropriation Act of 1936 (June 22, 1936):							
Road funds						9,914,271	9,914,271
All other						240,783,409	240,783,409
Total	89,799,300	532,000,000	125,092,431	886,701,519	159,508,410	258,348,549	2,051,450,209

TABLE 12.—*Detailed statement of total emergency funds appropriated or allocated to the Department of Agriculture during the fiscal years 1931 to 1937, inclusive; also amounts obligated thereunder during each fiscal year*

Appropriation or allocation and activity	Total appropriation or allocation, fiscal years 1931–37 [1]	Obligations							
		1931	1932	1933	1934	1935	1936	1937 [1]	Total
Emergency Construction Act (Dec. 20, 1930):									
Federal-aid highway system (1931)	[2] $79,947,000	$79,782,519							$79,782,519
National-forest highways (1931)	3,000,000	3,000,000							3,000,000
Improvement of national forests (1931) [3]	[4] 3,053,000	3,049,091							3,049,091
Public-lands highways (1931)	3,000,000	1,562,391	$1,400,520	$15,245	$20,928				2,999,084
Total	89,000,000	87,394,001	1,400,520	15,245	20,928				88,830,694
First Deficiency Appropriation Act, 1931:									
Emergency construction:									
Bureau of Animal Industry (1931)	12,500	12,495							12,495
Bureau of Dairy Industry (1931)	57,000	56,940							56,940
Bureau of Plant Industry (1931)	75,000	73,198							73,198
Bureau of Biological Survey (1931)	300,000	293,132							293,132
Insect infestations (Forest Service) (1931)	354,800	353,628							353,628
Total	799,300	789,393							789,393
Emergency Relief and Construction Act (July 21, 1932):									
Federal-aid highway system (1933)	120,000,000			120,000,000					120,000,000
National-forest highways (1933)	5,000,000			5,000,000					5,000,000
Improvement of national forests (1933) [3]	5,000,000			4,194,680					4,194,680
Public-lands highways (1933)	2,000,000			1,563,892	397,741	$30,437	$7,930		2,000,000
Total	132,000,000			130,758,572	397,741	30,437	7,930		131,194,680
National Industrial Recovery Act (June 16, 1933):									
Public Works allotments:									
Road funds:									
Federal highways (1933)	400,000,000			400,000,000					400,000,000
National-forest highways (1934)	14,600,000				14,600,000				14,600,000
National-forest roads, trails, bridges, and related projects (1934)	10,099,915				7,457,142	2,349,876	281,430	$11,467	10,099,915
Public-lands highways (1934)	5,000,000				5,000,000				5,000,000
Work-relief highways (special grants to certain States) (1934, $7,431,000; 1935, $900,000)	8,331,000				7,431,000	900,000			8,331,000
Engineering and accounting supervision of P. W. A. non-Federal highway projects (1934), $250,000; 1936, $50,000; 1937, $300,000)	600,000				11,812	203,372	77,241	122,552	414,977

Improvement of roads at Beltsville, Md. (1935)	10,725					3,057	7,580	88	10,725
Total	438,641,640			400,000,000	34,499,954	3,456,305	366,251	134,107	438,456,617
Physical improvements (exclusive of Forest Service):									
Office of the Secretary (1934)	2,718				2,718				2,718
Office of Experiment Stations (1934)	4,948				4,948				4,948
Weather Bureau (1934)	[5] 183,709				104,020	79,437	252		183,709
Bureau of Animal Industry (1934, $1,611,240; 1935, $426,550; 1936, $7,500)	2,045,290				1,111,190	857,225	65,734	10,386	2,044,535
Bureau of Dairy Industry (1934, $264,420; 1935, $23,450; 1936, $2,092)	287,962				137,140	148,023	2,799		287,962
Bureau of Plant Industry (1934, $1,038,556; 1936, $20,000; 1937, $20,000)	1,128,556				397,228	594,602	116,167	19,022	1,127,019
Bureau of Chemistry and Soils (1934)	123,784				76,183	47,601			123,784
Bureau of Entomology and Plant Quarantine (1934)	225,341				80,817	144,050	474		225,341
Bureau of Biological Survey (1934, $757,928; 1935, $10,000)	767,928				450,992	312,048	4,457		767,497
Bureau of Agricultural Engineering (1934)	223,634				166,315	57,319			223,634
Bureau of Home Economics (1934, $1,199; 1937, $8,600)	9,799				1,199			8,600	9,799
Food and Drug Administration (1934)	68,572				64,570	4,002			68,572
Total	5,072,241				2,597,320	2,244,307	189,883	38,008	5,069,518
Special projects:									
Transferred to Forest Service projects (1935)	1,000,000					896,853	100,284	2,863	1,000,000
Physical improvements, control of tree-destroying insects and diseases, and forest research (Forest Service) (1934)	14,671,645				8,463,128	5,979,587	218,673	10,257	14,671,645
National Arboretum (Bureau of Plant Industry) (1934)	395,252				385,253	9,999			395,252
Spray-residue investigations:									
Bureau of Plant Industry (1934)	39,924				6,359	31,290	2,275		39,924
Bureau of Chemistry and Soils (1934)	59,012				6,653	52,359			59,012
Bureau of Entomology and Plant Quarantine (1934)	100,966				36,709	64,257			100,966
Dutch-elm-disease control:									
Bureau of Plant Industry (1934)	73,903				73,903				73,903
Bureau of Entomology and Plant Quarantine (1935)	568,927					568,927			568,927
Barberry eradication (prevention of black stem rust):									
Bureau of Plant Industry (1934)	345,043				345,043				345,043
Bureau of Entomology and Plant Quarantine (1935)	376,544					364,527	12,017		376,544

See footnotes at end of table.

TABLE 12.—*Detailed statement of total emergency funds appropriated or allocated to the Department of Agriculture during the fiscal years 1931 to 1937, inclusive; also amounts obligated thereunder during each fiscal year*—Continued

Appropriation or allocation and activity	Total appropriation or allocation, fiscal years 1931–37	Obligations							
		1931	1932	1933	1934	1935	1936	1937	Total
National Industrial Recovery Act—Continued.									
Public Works allotments—Continued.									
Special projects—Continued.									
White-pine blister-rust control:									
Bureau of Plant Industry (1934)	$864, 137				$864, 137				$864, 137
Bureau of Entomology and Plant Quarantine (1935)	1, 153, 125					$1, 146, 188	$6, 937		1, 153, 125
Gypsy-moth control (Bureau of Entomology and Plant Quarantine) (1934)	2, 010, 080				1, 553, 938	448, 000	8, 142		2, 010, 080
Eradication of West Indian fruitfly (Bureau of Entomology and Plant Quarantine) (1934)	35, 958				4, 645	31, 313			35, 958
Rodent control on national forests (Bureau of Biological Survey) (1934)	296, 100				175, 454	119, 925	658		296, 037
Total	21, 990, 616				11, 915, 222	9, 713, 225	348, 986	$13, 120	21, 990, 553
Soil-conservation work:									
Repairs and improvements, soil-erosion stations (Bureau of Agricultural Engineering) (1934)	57, 648				52, 683	4, 965			57, 648
Construction of erosion-control nurseries:									
Bureau of Plant Industry (1934)	419, 167				96, 328	319, 229	3, 610		419, 167
Soil Conservation Service (transferred from Bureau of Plant Industry) (1935, $124,795; 1936, $12,176)	136, 971					104, 404	11, 307	16, 606	132, 317
Soil-erosion prevention (transferred from Interior Department to Department of Agriculture, Soil Conservation Service) (1934, $7,132,787; 1935, $2,866,854; 1936, $359)	10, 000, 000				1, 089, 018	8, 577, 340	284, 199	41, 876	9, 992, 433
Total	10, 613, 786				1, 238, 029	9, 005, 938	299, 116	58, 482	10, 601, 565
Total, Public Works allotments	476, 318, 283			$400, 000, 000	50, 250, 525	24, 419, 775	1, 204, 236	243, 717	476, 118, 253
Wildlife refuges (act of June 15, 1935):									
Legal work in connection with land acquisition (Office of the Solicitor) (1935)	130, 000						45, 734	72, 700	118, 434
Acquisition and development of wildlife refuges (Bureau of Biological Survey) (1935)	5, 857, 500						2, 827, 932	1, 954, 471	4, 782, 403
Expenses, North American Wildlife Conference (Bureau of Biological Survey) (1935)	12, 500						8, 000	4, 500	12, 500
Total	6, 000, 000						2, 881, 666	2, 031, 671	4, 913, 337

Agricultural Adjustment Administration:									
Rental and benefit payments, corn-hog adjustment program (supplementing processing taxes) (1934)	36, 970, 227				12, 124, 194	24, 830, 139			36, 954, 333
Administrative expenses in connection with codes under jurisdiction of Secretary of Agriculture (1934)	525, 000				250, 000	205, 119	44, 744		499, 863
Total	37, 495, 227				12, 374, 194	25, 035, 258	44, 744		37, 454, 196
Resettlement Administration:									
Rural rehabilitation (former subsistence homestead projects) (1935)	2, 479, 249					280, 440	2, 023, 724		2, 304, 164
Purchase of submarginal lands (1935)	17, 450, 373					154, 801	17, 048, 098	247, 474	17, 450, 373
Total	19, 929, 622					435, 241	19, 071, 822	247, 474	19, 754, 537
Civil Works projects (direct allotments):									
Weather Bureau: Compilation of meteorological data (1934)	9, 645				9, 645				9, 645
Bureau of Dairy Industry: Land, road, and equipment improvements (1934)	315				230				230
Bureau of Plant Industry: Physical improvements at field experiment stations (1934)	29, 002				29, 002				29, 002
Forest Service: Administration of forestry projects under Civil Works program (1934)	26, 938				26, 938				26, 938
Bureau of Chemistry and Soils: Maintenance work at soil experiment stations (1934)	24, 675				24, 675				24, 675
Bureau of Entomology and Plant Quarantine:									
Pest-mosquito control (1934)	73, 250				55, 715				55, 715
Dutch-elm-disease control (1934)	17, 500				12, 497				12, 497
Sweetpotato-weevil control (1934)	1, 000				807				807
Tick control (1934)	5, 375				1, 576				1, 576
Citrus-canker eradication (1934)	1, 450				1, 450				1, 450
Phony-peach eradication (1934)	7, 500				5, 902				5, 902
Extermination of brown-tail moths (1934)	5, 100				3, 876				3, 876
Bureau of Biological Survey:									
Improvement of fur resources (1934)	400				15				15
Rodent control in connection with typhus control (1934)	177, 917				168, 643				168, 643
Bureau of Agricultural Economics:									
Drafting work and construction of charts (1934)	254				254				254
Studies of rural tax delinquency, farm mortgages, and land values (1934, $65,407; 1935, $164,299)	229, 706				65, 407	164, 299			229, 706
Collection of statistics on price differentials for cotton of various qualities (1934)	20, 041				20, 041				20, 041
Collection of statistics on prices farmers pay (1934)	7, 729				7, 729				7, 729
Bureau of Home Economics: Rural housing survey (1934)	222, 702				156, 561	52, 386			208, 947
Total	860, 499				590, 963	216, 685			807, 648

TABLE 12.—*Detailed statement of total emergency funds appropriated or allocated to the Department of Agriculture during the fiscal years 1931 to 1937, inclusive; also amounts obligated thereunder during each fiscal year*—Continued

Appropriation or allocation and activity	Total appropriation or allocation, fiscal years 1931-37	Obligations							
		1931	1932	1933	1934	1935	1936	1937	Total
National Industrial Recovery Act—Continued.									
Emergency Conservation Work (act of Mar. 31, 1933, as amended):									
Bureau of Chemistry and Soils: Investigation of land poisoning (1934)	$30, 859				$17, 166	$13, 693			$30, 859
Forest Service: Acquisition of forest lands (1934)	17, 847, 000				14, 535, 173	3, 311, 827			17, 847, 000
Bureau of Biological Survey: Acquisition of refuge land (1934)	586, 559					586, 541			586, 541
Total	18, 464, 418				14, 552, 339	3, 912, 061			18, 464, 400
Total, National Industrial Recovery Act	559, 068, 049			$400, 000, 000	77, 768, 021	54, 019, 020	$23, 202, 468	$2, 522, 862	557, 512, 371
Emergency Appropriation Act, 1935 (June 19, 1934):									
Road funds:									
National Industrial Recovery highways (1935)	100, 000, 000				100, 000, 000				100, 000, 000
Forest roads and trails (1935)	10, 000, 000					10, 000, 000			10, 000, 000
Public-lands highways (1935)	2, 500, 000					2, 500, 000			2, 500, 000
Improvement of roads at Beltsville, Md. (1935)	2, 239						2, 128	111	2, 239
Total	112, 502, 239				100, 000, 000	12, 500, 000	2, 128	111	112, 502, 239
Emergency relief and public works (other than roads):									
Office of the Secretary (Beltsville Agricultural Research Center):									
Installation of sewage treatment and disposal system (1935)	147, 000					140, 654	6, 346		147, 000
Construction of feed mill and granary (1937)	50, 000							41, 453	41, 453
Bureau of Animal Industry: Physical improvements at field stations (1935, $25,936; 1936, $211,101)	237, 037					5, 175	20, 761	206, 454	232, 390
Forest Service (Emergency Conservation Work, under act of Mar. 31, 1933, as amended): Acquisition of forest lands (1935)	10, 313, 000					10, 313, 000			10, 313, 000
Bureau of Biological Survey: Restoration, improvement, and development of wildlife refuges (1935)	1, 922, 500					1, 922, 500			1, 922, 500
Bureau of Agricultural Engineering: Physical improvements at field stations (1936)	17, 250						158	16, 808	16, 966
Soil Conservation Service: Soil-erosion prevention (transferred from Interior Department to Department of Agriculture) (1935)	3, 676, 649					2, 112, 926	1, 366, 092	84, 015	3, 563, 033
Total	16, 363, 436					14, 494, 255	1, 393, 357	348, 730	16, 236, 342

Loans and relief in stricken agricultural areas:									
Extension Service: Educational phases of drought-adjustment programs (1935)	1,705,134					1,705,134			1,705,134
Bureau of Animal Industry: Purchase of surplus cattle (1935)	647,338					646,231			646,231
Bureau of Entomology and Plant Quarantine: Japanese beetle control, St. Louis, Mo. (1935)	61,631					61,501			61,501
Great Plains shelterbelt project:									
Weather Bureau (1935)	1,481					1,481			1,481
Bureau of Plant Industry (1935)	10,718					10,718			10,718
Forest Service (1935)	844,524					844,524			844,524
Bureau of Chemistry and Soils (1935)	12,910					12,909			12,909
Bureau of Entomology and Plant Quarantine (1935)	7,967					7,967			7,967
Bureau of Biological Survey (1935)	25,379					25,379			25,379
Agricultural Adjustment Administration:									
Purchase of seed (1935)	19,179,358					19,179,358			19,179,358
Purchase and distribution of livestock (1935)	57,062,209					57,062,209			57,062,209
Administrative expenses (1935)	4,298,122					4,298,122			4,298,122
Unobligated part of allotment of $80,743,351, June 30, 1937	203,362								
Resettlement Administration: Purchase of submarginal lands (1935)	3,389,487					3,284,872			3,284,872
Total	87,449,620					87,140,405			87,140,405
Total, Emergency Appropriation Act, 1935	216,315,295				100,000,000	114,134,660	1,395,485	348,841	215,878,986
Puerto Rico and Hawaii trust funds and substitute funds:									
Allotments from sugar processing tax collections in Puerto Rico and Hawaii, authorized by sec. 8 of Jones-Costigan Act of May 9, 1934, amending sec. 15 (f) of the Agricultural Adjustment Act:									
Puerto Rico:									
Agricultural Adjustment Administration: Rental and benefit payments in connection with adjustment of sugar cane production (1936)	1,552,104						1,552,104		1,552,104
Office of Experiment Stations: Experiments in the propagation and breeding of tropical plants, and studies of domestic-animal parasites (1935)	32,855					1,598	31,257		32,855
Bureau of Chemistry and Soils: Soil surveys (1935)	15,042					13,562	1,480		15,042
Bureau of Entomology and Plant Quarantine: Insect-pest survey (1936)	40,637						40,637		40,637
Soil Conservation Service: Soil-erosion survey (1935)	7,208						7,208		7,208
Total	1,647,846					15,160	1,632,686		1,647,846

TABLE 12.—*Detailed statement of total emergency funds appropriated or allocated to the Department of Agriculture during the fiscal years 1931 to 1937, inclusive; also amounts obligated thereunder during each fiscal year*—Continued

Appropriation or allocation and activity	Total appropriation or allocation, fiscal years 1931–37	Obligations							
		1931	1932	1933	1934	1935	1936	1937	Total
Puerto Rico and Hawaii trust funds and substitute funds—Continued.									
Allocations from sugar processing tax collections in Puerto Rico and Hawaii—Continued.									
Hawaii:									
Office of Experiment Stations:									
Taro investigations (1936)	$9,428						$9,428		$9,428
Liver-fluke investigations (1936)	3,345						3,345		3,345
Rat-abatement campaign (1936)	981						981		981
Development of truck farming and improvement of marketing facilities for farm products (1936)	1,809						1,809		1,809
Development of livestock feed (1936)	116						116		116
Development of tropical fruits and nuts (1936)	404						404		404
Promotion of the poultry industry (1936)	171						171		171
Bureau of Chemistry and Soils: Soil surveys (1935)	9,770					$5,806	3,964		9,770
Bureau of Entomology and Plant Quarantine: Fruitfly control (1936)	13,283						13,283		13,283
Total	39,307					5,806	33,501		39,307
Total, Puerto Rico and Hawaii trust funds (sugar taxes)	1,687,153					20,966	1,666,187		1,687,153
Allotments from $700,000 appropriation for Payments for agricultural adjustment, provided by Supplemental Appropriation Act, 1936, in substitution for Puerto Rico and Hawaii trust funds:									
Puerto Rico:									
Office of Experiment Stations: Experiments in the propagation and breeding of tropical plants, and studies of domestic-animal parasites (1936)	80,145						39,675	$33,595	73,270
Bureau of Chemistry and Soils: Soil surveys (1936)	24,958						18,232	6,683	24,915
Bureau of Entomology and Plant Quarantine: Insect-pest survey (1936)	52,363						39,286	12,727	52,013

Soil Conservation Service: Soil-erosion survey (1936)	74,792						6,894	13,139	20,033
Total	[6] 232,258						104,087	66,144	170,231
Hawaii:									
Office of Experiment Stations:									
Taro investigations (1936)	40,572						17,035	17,805	34,840
Liver-fluke eradication (1936)	36,655						10,143	14,439	24,582
Rat-abatement campaign (1936)	109,019						38,090	66,593	104,683
Development of truck farming and improvement of marketing facilities for farm products (1936)	58,191						15,381	31,560	46,941
Development of livestock feed (1936)	69,884						10,781	33,451	44,232
Development of tropical fruits and nuts (1936)	49,596						11,029	28,924	39,953
Promotion of the poultry industry (1936)	29,829						5,473	11,642	17,115
Bureau of Chemistry and Soils: Soil surveys (1936)	5,230						5,229		5,229
Bureau of Entomology and Plant Quarantine: Fruit-fly control (1936)	66,717						42,217	19,500	61,717
Total	[6] 465,693						155,378	223,914	379 292
Total, substitution for Puerto Rico and Hawaii trust funds	[6] 697,951						259,465	290,058	549,523
Total, Puerto Rico and Hawaii trust funds and substitute funds	2,385,104					20,966	1,925,652	290,058	2,236,676
Emergency Relief Appropriation Act of 1935 (Apr. 8, 1935):									
Road funds	499,621,865				$100,000,000	399,621,865			499,621,865
All other	301,562,916					1,043,170	240,654,956	54,489,498	296,187,624
Total (for details see table 13)	801,184,781				100,000,000	400,655,035	240,654,956	54,489,498	795,809,489
Emergency Relief Appropriation Act of 1936 (June 22, 1936):									
Road funds	9,914,271							9,651,230	9,651,230
All other	240,783,409							202,357,048	202,357,048
Total (for details see table 13)	250,697,680							212,008,278	212,008,278
Grand total	2,051,450,209	$88,183,394	$1,400,520	$530,773,817	278,186,690	568,870,118	267,186,491	269,659,537	2,004,260,567

[1] As of June 30, 1937.
[2] Excludes $53,000 transferred to Forest Service and included under item Improvment of national forests.
[3] Primarily road construction and maintenance.
[4] Includes $53,000 transferred from item Federal-aid highway system.
[5] Includes $149,984 for replacing river gages.
[6] Available until expended.

TABLE 13.—*Allocations to Department of Agriculture from funds provided by Emergency Relief Appropriation Acts of 1935 and 1936 and obligations thereunder, fiscal years 1935, 1936, and 1937 (as of June 30, 1937)*

Bureau and activity	Allocations				Obligations			
	1935	1936	1937	Total	1935	1936	1937	Total
Emergency Relief Appropriation Act of 1935 (Apr. 8, 1935):								
Office of the Solicitor: Title examination work in connection with forest and wildlife land acquisition:								
Regular allotment		$1,358,500	$82,190	$1,440,690		$890,371	$528,687	$1,419,058
Emergency Conservation Work	$400,000			400,000	$223,210	166,592	6,935	396,737
Total	400,000	1,358,500	82,190	1,840,690	223,210	1,056,963	535,622	1,815,795
Office of Information: Printing of operating forms	5,000	15,000		20,000		4,958	14,958	19,916
Extension Service:								
Renovating of agricultural exhibits and improvement of warehouse facilities		4,059		4,059		4,059		4,059
Wind-erosion control in southern Great Plains area (authorized by sec. 4 of Soil Conservation and Domestic Allotment Act of Feb. 29, 1936)		2,000,000		2,000,000		1,950,000	50,000	2,000,000
Total		2,004,059		2,004,059		1,954,059	50,000	2,004,059
Weather Bureau:								
Development of a method of long-range weather forecasting		13,795		13,795		12,164	1,631	13,795
Repair or replacement of river gages damaged or destroyed by floods of 1936		5,000		5,000			5,000	5,000
Total		18,795		18,795		12,164	6,631	18,795
Bureau of Animal Industry:								
Physical improvements at Chinsegut Hill Sanctuary, Brooksville, Fla		28,900		28,900		28,520	269	28,789
Eradication of liver flukes in sheep and cattle		168,692		168,692		91,000	77,371	168,371
Elimination of cattle fever tick		890,150		890,150		804,569	85,295	889,864
Total		1,087,742		1,087,742		924,089	162,935	1,087,024

Bureau of Dairy Industry: Physical improvements at Lewisburg (Tenn.) dairy station		2,990		2,990		2,990		2,990
Bureau of Plant Industry: Physical improvements at agricultural stations and experiment farms		39,770		39,770		39,770		39,770
Forest Service:								
Physical improvements, protection, and development work on national-forest and adjacent privately owned lands, forestry research, etc	13,827,500	716,125		14,543,625		13,422,376	1,112,544	14,534,920
Acquisition of forest lands		12,475,000		12,475,000		12,475,000		12,475,000
Acquisition of forest lands, administrative expenses (Emergency Conservation Work)	500,000			500,000	409,584	84,440	5,976	500,000
Acquisition of lands, Jefferson National Forest (Emergency Conservation Work)	60,000			60,000			60,000	60,000
Administrative expenses	1,172,500	553,620	30,670	1,756,790		1,541,809	214,981	1,756,790
Total	15,560,000	13,744,745	30,670	29,335,415	409,584	27,523,625	1,393,501	29,326,710
Bureau of Entomology and Plant Quarantine:								
Brown-tail moth control		682,250		682,250		610,000	69,440	679,440
Citrus canker eradication		145,300		145,300		132,742	12,187	144,929
Gypsy-moth control		2,653,250		2,653,250		2,394,300	256,040	2,650,340
Peach mosaic survey and control		54,948		54,948		38,934	15,924	54,858
Phony peach disease control		735,561		735,561		687,556	41,176	728,732
White-pine blister-rust control		4,388,804		4,388,804		3,539,985	844,919	4,384,904
Barberry eradication and prevention of black stem rust		1,850,500		1,850,500		1,489,741	358,959	1,848,700
Locating and destroying Thurberia plants		167,474		167,474		124,227	43,247	167,474
Dutch-elm disease eradication	249,944	2,628,188		2,878,132	48,563	2,650,142	179,427	2,878,132
Construction of insectaries, storage facilities, etc		9,074		9,074		8,181	893	9,074
European corn-borer survey		83,641		83,641		83,641		83,641
Locating and destroying wild cotton plants		101,000		101,000		59,806	40,094	99,900
Administrative expenses		34,801		34,801		28,220	6,581	34,801
Total	249,944	13,534,791		13,784,735	48,563	11,847,475	1,868,887	13,764,925
Bureau of Biological Survey:								
Development of wildlife refuges in North Dakota		287,289		287,289		238,077	47,750	285,827
Acquisition of wildlife refuge areas		406,441	9,346	415,787		406,441	9,346	415,787
Administrative expenses		209,190		209,190		199,035	10,155	209,190
Total		902,920	9,346	912,266		843,553	67,251	910,804
Bureau of Public Roads:								
Construction of highways, roads, and streets, and grade-crossing elimination	399,621,865			399,621,865	399,621,865			399,621,865
National Industrial Recovery highway funds	[1] 100,000,000			100,000,000				(2)
Total	499,621,865			499,621,865	399,621,865			[4] 399,621,865

See footnotes at end of table.

TABLE 13.—*Allocations to Department of Agriculture from funds provided by Emergency Relief Appropriation Acts of 1935 and 1936 and obligations thereunder, fiscal years 1935, 1936, and 1937 (as of June 30, 1937)*—Continued

Bureau and activity	Allocations				Obligations			
	1935	1936	1937	Total	1935	1936	1937	Total
Emergency Relief Appropriation Act of 1935—Continued.								
Bureau of Agricultural Engineering: Physical improvements at field stations		$7,143		$7,143		$7,143		$7,143
Soil Conservation Service:								
National program of soil conservation	$17,458,000	1,536,198	$260,000	19,254,198		16,399,385	$2,529,938	18,929,323
Administrative expenses	2,500,000	3,954,040		6,454,040		4,973,416	1,349,370	6,322,786
Total	19,958,000	5,490,238	260,000	25,708,238		21,372,801	3,879,308	25,252,109
Total, Emergency Relief Appropriation Act of 1935 (exclusive of Resettlement Administration)	535,794,809	38,206,693	382,206	574,383,708	$400,303,222	65,589,590	7,979,093	[4] 473,871,905
Resettlement Administration:								
Rehabilitation loans and grants	58,140,988	41,803,500		99,944,488		99,890,178		99,890,178
Resettlement projects	41,859,012	21,648,400	5,034,060	68,541,472		27,446,466	36,731,792	64,178,258
Purchase and development of submarginal lands		20,009,110	1,856,003	21,865,113		17,069,510	4,349,638	21,419,148
Administrative expenses	1,250,000	35,200,000		36,450,000	361,813	30,659,212	5,428,975	36,450,000
Total	101,250,000	118,661,010	6,890,063	226,801,073	361,813	175,065,366	46,510,405	221,937,584
Total, Emergency Relief Appropriation Act, of 1935, Department of Agriculture	637,044,809	156,867,703	7,272,269	801,184,781	400,665,035	240,654,956	54,489,498	[4] 695,809,489
Emergency Relief Appropriation Act of 1936 (June 22, 1936): [3]								
Office of the Secretary: Departmental reserve			38,446	38,446				
Office of the Solicitor: Title-examination work in connection with acquisition of forest lands			146,200	146,200				
Bureau of Animal Industry:								
Eradication of liver flukes in sheep and cattle			75,000	75,000			73,539	73,539
Elimination of cattle fever tick			535,000	535,000			494,130	494,130
Total			610,000	610,000			567,669	567,669
Forest Service:								
Construction and maintenance of national-forest improvements, control of tree diseases, insects, and rodents, and planting			12,681,674	12,681,674			12,479,097	12,479,097
Surveying, mapping, and boundary tracing of national forests			1,445,365	1,445,365			1,407,212	1,407,212

Construction of parks and recreational facilities			2,558,211	2,558,211			2,506,743	2,506,743
Administrative expenses			856,099	856,099			494,632	494,632
Total			17,541,349	17,541,349			16,887,684	16,887,684
Bureau of Entomology and Plant Quarantine:								
Brown-tail moth control			477,699	477,699			463,700	463,700
Citrus canker eradication			195,500	195,500			174,300	174,300
Gypsy-moth control			2,026,000	2,026,000			2,002,000	2,002,000
Locating and removing peach mosaic			127,000	127,000			119,834	119,834
Phony peach disease control			491,333	491,333			472,333	472,333
White-pine blister-rust control			2,904,625	2,904,625			2,834,625	2,834,625
Barberry eradication and prevention of black stem rust			1,614,750	1,614,750			1,584,750	1,584,750
Locating and destroying Thurberia plants			99,250	99,250			93,750	93,750
Dutch-elm disease eradication			4,258,875	4,258,875			4,242,538	4,242,538
Mormon-cricket control			425,000	425,000			335,000	335,000
Administrative expenses			59,000	59,000			47,452	47,452
Total			12,679,032	12,679,032			12,370,282	12,370,282
Bureau of Biological Survey:								
Improvement of wildlife refuge areas			1,588,926	1,588,926			1,572,322	1,572,322
Administrative expenses			47,500	47,500			39,868	39,868
Total			1,636,426	1,636,426			1,612,190	1,612,190
Bureau of Public Roads: Construction and repair of roads and bridges damaged or destroyed by floods of 1936			9,914,271	9,914,271			9,651,230	9,651,230
Bureau of Agricultural Economics: Studies of farm mortgages, land values, transfers, and farm taxes			2,133,760	2,133,760			2,003,760	2,003,760
Bureau of Home Economics:								
Study of consumption of goods and services by rural and town families			1,406,104	1,406,104			1,398,855	1,398,855
Cooperative study of body measurements for garment and pattern sizes			39,000	39,000			19,000	19,000
Administrative expenses			100,000	100,000			21,485	21,485
Total			1,545,104	1,545,104			1,439,340	1,439,340
Soil Conservation Service:								
National program of soil conservation, including control operations, erosion surveys, etc			6,238,761	6,238,761			5,752,392	5,752,392
Administrative expenses			218,750	218,750			40,845	40,845
Total			6,457,511	6,457,511			5,793,237	5,793,237
Total, Emergency Relief Appropriation Act of 1936 (exclusive of Resettlement Administration)			52,702,099	52,702,099			50,325,392	50,325,392

See footnotes at end of table.

TABLE 13.—*Allocations to Department of Agriculture from funds provided by Emergency Relief Appropriation Acts of 1936 and 1935 and obligations thereunder, fiscal years 1935, 1936, and 1937 (as of June 30, 1937)*—Continued

Bureau and activity	Allocations				Obligations			
	1935	1936	1937	Total	1935	1936	1937	Total
Emergency Relief Appropriation Act of 1936—Continued.								
Resettlement Administration:								
Rehabilitation loans and grants			$107,500,000	$107,500,000			$101,544,778	$101,544,778
Resettlement projects			25,500,000	25,500,000			16,505,321	16,505,321
Land development			22,195,581	22,195,581			20,809,024	20,809,024
Administrative expenses			42,800,000	42,800,000			22,823,763	22,823,763
Total			197,995,581	197,995,581			161,682,886	161,682,886
Total, Emergency Relief Appropriation Act of 1936, Department of Agriculture			250,697,680	250,697,680			212,008,278	212,008,278
Grand total:								
Emergency Relief Appropriation Act of 1935	$637,044,809	$156,867,703	7,272,269	801,184,781	$400,665,035	$240,654,956	54,489,498	695,809,489
Emergency Relief Appropriation Act of 1936			250,697,680	250,697,680			212,008,278	212,008,278
Total	637,044,809	156,867,703	257,969,949	1,051,882,461	400,665,035	240,654,956	266,497,776	[4] 907,817,767

[1] Made immediately available by Agricultural Appropriation Act, 1936, from appropriations provided by Emergency Relief Appropriation Act of 1935.
[2] Entire allocation actually obligated in fiscal year 1934, as authorized by sec. 1, act of June 18, 1934.
[3] Provided under Title II of First Deficiency Appropriation Act, fiscal year 1936.
[4] Exclusive of $100,000,000 allocation for National Industrial Recovery highways from funds provided by Emergency Relief Appropriation Act of 1935, allotted to States for obligation in 1934.

FUNDS OF THE RESETTLEMENT ADMINISTRATION [1]

As indicated in detail by tables 12 and 13, a total of $448,115,763 was made available during the fiscal years 1935, 1936, and 1937, from emergency funds provided by the National Industrial Recovery Act, the Emergency Appropriation Act, fiscal year 1935, and the Emergency Relief Appropriation Acts of 1935 and 1936 for carrying out the rehabilitation, resettlement, and land-acquisition and development programs of the Resettlement Administration; and against these funds total obligations of $406,659,879 were incurred up to June 30, 1937, as shown in table 14.

TABLE 14.—*Resettlement Administration allocations and obligations, fiscal years 1935–37*

Item	1935	1936	1937	Total
Allocations	$124, 569, 109	$118, 661, 010	$204, 885, 644	$448, 115, 763
Obligations	4, 081, 926	194, 137, 188	208, 440, 765	406, 659, 879

RECEIPTS FROM DEPARTMENT'S ACTIVITIES, 1937

Receipts accruing incident to the operations of the Department during the fiscal year 1937 totaled $50,504,021. This total is classified into three groups, showing (1) the amounts accruing on account of miscellaneous activities, (2) the repayment of loans made by the Resettlement Administration, together with interest thereon, and (3) proceeds from the sale of products by the Federal Surplus Commodities Corporation, as follows:

Miscellaneous collections:		
From business on the national forests:		
Timber sales	$2, 944, 181	
Grazing fees	1, 581, 173	
All other objects	431, 593	
		$4, 956, 947
Contributions from private cooperators, appropriated as a trust fund (Cooperative Work, Forest Service) for various activities on the national forests and privately owned timberlands		801, 593
Contributions form private cooperators for expenditure under trust arrangements:		
Resettlement Administration	$10, 031, 228	
Deposits of unearned fees received from licensees under the Commodity Exchange Act	18, 304	
Deposits in part payment of salaries of inspectors under the Sea Food Inspection Act	59, 895	
Miscellaneous	91, 077	
		10, 200, 504
From sale of hunting stamps (Migratory Bird Hunting Stamps, special fund)		616, 473
From sale of products of migratory-bird refuges, Migratory Bird Conservation Act		55, 307
From fees:		
Perishable Agricultural Commodities Act	124, 279	
Alaska game laws	24, 227	
Naval-stores grading	9, 315	
United States Warehouse Act	12, 015	
Miscellaneous fees	3, 282	
		173, 118
Reimbursements for services in inspecting agricultural products, miscellaneous refunds, etc.		566, 827
Sale of Government property and products, payments for marketing privileges, and miscellaneous services		3, 334, 476
Miscellaneous		69, 007
Total, Miscellaneous collections		20, 774, 252
Repayment of loans (Resettlement Administration):		
Repayment of principal on account of loans	$22, 089, 409	
Interest collections on account of loans	923, 128	
Total, Repayment of loans		23, 012, 537
Federal Surplus Commodities Corporation: Sale of hides		6, 717, 232
Total		50, 504, 021

DIVISION OF ACCOUNTS

During the year the Department extended to a considerable degree its utilization of the facilities afforded by the 19 regional disbursing offices of the Division of Disbursement, Treasury Department, in the continental United States and the 4 disbursing agencies in Alaska, Hawaii, Puerto Rico, and Costa Rica, to effectuate

[1] Name changed to Farm Security Administration, effective September 1, 1937, pursuant to Secretary of Agriculture Memorandum No. 732, dated September 1, 1937.

a more expeditious payment of field pay rolls and miscellaneous vouchers than is possible in making such payments through the central disbursing office in Washington. The establishment of 11 regional field offices under the Soil Conservation Service, staffed with auditing and accounting personnel, has enabled the Department to arrange with the Division of Disbursement, Treasury Department, to permit each of these regional administrative offices to schedule not only pay rolls but other classes of vouchers to the most conveniently located regional disbursing office for payment, instead of submitting such vouchers through the bureau accounting office to the central disbursing office in Washington. These regional field administrative offices are located in Albuquerque, N. Mex.; Spartanburg, S. C.; Dayton, Ohio; Williamsport, Pa.; Fort Worth and Amarillo, Tex; Spokane, Wash.; Santa Paula, Calif.; Des Moines, Iowa; Salina, Kans.; and Rapid City, S. Dak. They were placed into decentralized operation as to fiscal and accounting matters in the order named after each office had been inspected in person by a representative of the Office of Budget and Finance to determine whether the personnel, equipment, and records maintained appeared to justify such action.

In addition to the large number of miscellaneous vouchers which are paid through the regional disbursing offices for the Forest Service, Bureau of Public Roads, and the Soil Conservation Service, these disbursing offices are now paying semimonthly pay rolls covering the salaries of approximately 29,000 field employees of the various bureaus of the Department. This enables these employees to receive their salaries much more promptly than they have heretofore, thus meeting a need which has existed in this Department for many years.

During the year the Agricultural Adjustment Administration effected a decentralization of its Washington administrative organization, establishing various divisional offices on a geographic basis, designated as the Southern, Western, North-Central, East-Central, Northeast, and Insular Divisions. Under the first three of these divisions administrative field offices were set up in each State within the geographic boundaries of the respective division, which permitted the use of the facilities of the regional disbursing offices to accomplish more expeditious payment of the agricultural conservation payments, the county agricultural conservation association expenses, and the salaries of administrative personnel in the field.

The Division of Disbursement of the Treasury Department, both in Washington and through its field offices, has cooperated with the Department of Agriculture in every possible way in connection with these matters and is entitled to, and does have, the sincere appreciation of our people in every locality.

This progressive decentralization of disbursing functions, with its attending extension of the utilization by the Department of the facilities of the regional disbursing offices, has caused a material increase in the accounting and bookkeeping work of the Division of Accounts.

The work was also greatly augmented during the year by the efforts which were made to comply with the requirements of three general regulations prescribed by the General Accounting Office, effective July 1, 1936. These regulations are: No. 83, dated June 9, 1936, entitled "Reporting Disbursements and Collections under Limitations in Appropriations"; No. 84, dated June 15, 1936, entitled "Receipt and Appropriation Symbols"; and No. 87, dated June 25, 1936, entitled "Accounting for Moneys Received by Officers and Employees of the United States."

While regulations No. 83, which prescribes the procedure to be followed by administrative organizations in reporting to the General Accounting Office disbursements and collections in accordance with legislative limitations contained in appropriation acts, became effective July 1, 1936, a list of the symbols to be used thereunder was not received from that office until just prior to July 15, 1936. An examination of this list disclosed that the limitation and subappropriation symbols assigned therein to the appropriations of the Department of Agriculture could not be used consistently with the accounting system prescribed several years ago by the General Accounting Office for the Bookkeeping and Accounting Section of the Division of Accounts, wherein the departmental records had previously been maintained by subappropriation accounts under each main head of appropriation. It therefore became necessary to revise these subappropriation and limitation symbols. This revision was not completed and approved by the General Accounting Office until late in October 1936.

General regulations No. 87, Accounting for Moneys Received by Officers and Employees of the United States, provided, among other things, for the revision of four existing standard forms (Nos. 1044, 1046, 1070, and 1080). As many thousands of the forms were needed, multigraphing even a temporary supply

seemed out of the question. Although no printed copies of the forms were available in the Government Printing Office, some of the field disbursing officers were unwilling to pass pay rolls without the new forms 1070. However, an informal understanding was consummated whereby such field disbursing officers would accept the rolls for payment without the forms until supplies thereof could be obtained from the Government Printing Office. Another provision of regulations No. 87 permitted a change in the manner of stating accountable officers' collection accounts. Prior to the effective date of these regulations such officers were required to reflect all collections for the accounting period under individual appropriations and fund accounts. The provisions of regulations No. 87 required the reporting of collections under only two major classifications, namely, Miscellaneous Collections and Special Deposits. This necessitates making a break-down by individual appropriation and fund accounts, in the Division of Accounts, of all collections received by the various disbursing officers and reported under these two major classifications. This is accomplished through an analysis (by appropriations and funds) of items of collection included on original schedules accompanying regional disbursing officers' accounts current for field collections and on copies of the chief disbursing officer's journal ledger sheets for Washington collections. The totals of such collections are then checked by appropriations and funds against standard Forms No. 1095 prepared and submitted to the Division of Accounts by the various bureau accounting offices.

The work performed by the Division of Accounts during the fiscal year involved, in addition to the necessary bookkeeping operations, the examination and submission to the central office of the Division of Disbursement, Treasury Department, in Washington, for payment of 722,953 administratively approved vouchers and pay rolls, amounting to $495,828,879, and the examination and submission to the General Accounting Office of 6,320 claims for settlement, totaling $21,567,745. These figures do not include $128,763,868 in agricultural conservation payments made in Washington for the Northeast, East-Central, and Insular Divisions of the Agricultural Adjustment Administration, under the provisions of the Soil Conservation and Domestic Allotment Act, and adjustment payments under the old agricultural adjustment program, the vouchers for which are not handled by the Division of Accounts.

To make the necessary disbursing funds available to the chief disbursing officer, Division of Disbursement, Treasury Department, for the payment of these vouchers, pay rolls, settlements, etc., and to enable his regional disbursing officers in the continental United States, insular possessions, and territories, and for the departmental temporary special disbursing agents stationed in foreign countries to make payment of the vouchers and pay rolls schedules to them, requisitions and transfer forms were prepared in or cleared through the Division of Accounts which placed $738,586,847 to the disbursing credit of these officers. This involved the handling through the bookkeeping records of the Division of 44 separate disbursing accounts, subdivided into 191 checking accounts under specific disbursing symbols. The Division of Accounts received and administratively examined a total of 3,780 disbursing officers' accounts current during the fiscal year, an average of 315 each month.

During the year the Division of Accounts received 10,682 schedules of collections from the various bureaus of the Department, accompanied by 80,978 remittances in the form of checks, drafts, money orders, and cash, totaling $2,708,748.

In addition to the foregoing, the Division of Accounts handled Presidential allocations of $252,762,252 made to the Department from the Emergency Relief Appropriations Acts of 1935 and 1936, which required considerable time and effort in clearing through the Bureau of the Budget, the Treasury Department, and the General Accounting Office and in furnishing advice thereof to the bureaus and offices and the officials of the Department concerned. While no appropriation accounts were maintained in the general ledgers of the Division in connection with emergency relief allocations, it was necessary, for administrative purposes, to keep a complete record and file on all such allocations for preparing various reports and statements thereon, to check project authorizations and allotments made therefrom, and for use in preparing and handling numerous adjustments and recisions therein.

BUREAU ACCOUNTING SERVICE

The Bureau Accounting Service has continued during the fiscal year 1937 the administrative audit and accounting for funds appropriated or otherwise contributed in connection with the broad activities of the Office of the Secretary, Office of the Solicitor, Office of Information, Office of Experiment Stations, Extension Service (including a large volume of work in connection with activities

covered by allotments of funds from the Agricultural Adjustment Administration), the Commodity Exchange Administration, and the Bureau of Home Economics. The work includes continuous study of changing fiscal procedures, accounting methods, and recording and reporting forms, involving also analyses of results with a view to advancing the adequacy of methods and accomplishment.

During the fiscal year 1936 the General Accounting Office made a survey of the activities of the Central Supply Section and their effect on the Department's appropriation for miscellaneous expenses and prescribed a system of general ledger and allotment accounts to insure the presence in the Treasury at all times of adequate cash balances to meet current obligations. This system was installed effective July 1, 1936, and on August 31, 1936, it was enlarged to include all activities for the Office of the Secretary proper.

On October 6, 1936, the same general system was prescribed for the Office of the Solicitor and, following considerable delay incident to securing a comprehensive evaluated inventory of property in custody of the Division, this system was installed November 24, 1936, effective as of July 1, 1936.

The same standard Government accounting system was prescribed for the Office of Experiment Stations on October 21, 1936 and, following the construction of the required property inventory, was installed during January 1937 as of July 1, 1936. Incidentally, the procedure for providing the Director of Research with suitable current reports on funds allocated to the various bureaus for projects under the Bankhead-Jones Act of June 29, 1935, was perfected and placed in operation.

A summary of the work of the Bureau Accounting Service is shown in tables 15, 16, and 17.

TABLE 15.—*Auditing, fiscal years 1934–37*

Fiscal year	Claims audited	Purchase orders pre-audited	Contracts audited	Items involved
1934	52,072	8,293	158	833,616
1935	85,053	6,657	368	1,253,678
1936	93,056	10,492	856	1,189,442
1937	61,446	9,329	429	697,057

TABLE 16.—*Record of pay rolls and miscellaneous items, fiscal years 1934–37*

Fiscal year	Pay rolls prepared	Pay-roll items	Letters of authorization written	Collection claims filed	Transportation requests issued	Bills of lading issued
1934	25,124	338,965	9,959	270	5,565	1,935
1935	52,901	734,279	7,564	201	7,780	12,078
1936	40,033	591,416	6,994	298	13,874	17,499
1937	24,510	489,423	2,201	305	8,447	4,537

TABLE 17.—*Funds under direct and indirect accounting control of the Bureau Accounting Service, fiscal years 1934–37*

Item	1934	1935	1936	1937
General expense appropriations and transferred funds	$4,601,017	$3,235,038	$3,527,687	$4,551,737
Warranted to States	13,119,096	13,136,096	17,885,000	22,745,014
Offset by States	6,198,096	6,248,258	6,918,636	5,885,014
Supplemental State funds	4,321,958	4,793,374	5,525,653	5,959,276
Allotments from Agricultural Adjustment Administration	11,832,803	23,843,544	15,749,430	3,933,673
Other funds	1,526,058	2,850,332	4,024,054	3,547,026
Total	41,599,028	54,106,642	53,630,460	46,621,740

The decrease for 1937 in the volume of work reported in tables 15 and 16 is due mainly to the adoption by the Agricultural Adjustment Administration of a plan to transfer the pay-rolling and payment of salaries of field personnel to regional offices in the field. This reduction, however, has been considerably more than offset by the additional work involved in the introduction of the new account-

ing systems, five of which remain for installation during the current (1938) fiscal year.

DIVISION OF PURCHASE, SALES, AND TRAFFIC

The record of business transacted by the Division of Purchase, Sales, and Traffic during the fiscal years 1935, 1936, and 1937 is set out in table 18.

TABLE 18.—*Purchases, sales, and other activities of the Division of Purchase, Sales, and Traffic, fiscal years 1935–37*

Item	1935	1936	1937
Bid Section:			
Bid transactions ... number	4,084	8,816	8,223
Flow of bids:			
First quarter ... percent	21	20	21
Second quarter ... do	18	20	19
Third quarter ... do	24	23	25
Fourth quarter ... do	37	37	35
Bureau purchase orders in excess of $500 approved ... number	139	256	1,735
Aggregate amount ... dollars	223,591	314,944	1,928,032
Forest-road contracts examined prior to approval by Secretary ... number	109	78	92
Aggregate amount ... dollars	6,276,077	4,840,931	6,080,090
Value of property in the District of Columbia transferred from one bureau to another in Department ... dollars	3,648	11,107	3,654
Initial value of worn-out property transferred to Procurement Division, Treasury Department ... dollars	51,839	56,036	31,034
Traffic Section:			
Freight routings furnished:			
Less than carload ... number	9,207	17,735	13,489
Carload ... do	1,808	3,097	2,941
Express routings furnished ... do	5,192	10,508	8,946
Rates furnished:			
Freight ... do	20,446	62,985	83,952
Express ... do	209	626	3,506
Passenger, rail and water ... do	8,700	9,579	6,860
Parcel post ... do	32	132	1,189
Air, passenger ... do	75	240	114
Itineraries furnished ... do	1,549	1,872	2,267
Central Supply Section:			
Stock issues during year ... dollars	577,174	923,491	866,488
Requisitions for stores, filled ... number	37,611	40,300	43,353
Requisitions for printed forms, filled ... do	[1] 21,000	[1] 23,000	[1] 25,000
Purchase orders (both to maintain stocks and for other activities) ... number	13,641	41,044	39,340
Money value involved, all purchase orders ... dollars	2,005,079	14,076,503	8,609,897
Average money value per purchase order ... dollars	147	343	218
Experimental byproducts sold: For deposit to miscellaneous receipts ... dollars	30,676	32,861	46,653

[1] Estimated.

With the continuance of relief work and resultant emergency activities in all branches of the Department during the year, abnormally large demands upon all sections of the Division of Purchase, Sales, and Traffic for service likewise continued throughout the year, although pressure along some lines was not so great as in the preceding year.

BID TRANSACTIONS

In the report for the fiscal year 1936 attention was invited to an exceptional increase in the number of bid and acceptance contracts negotiated by the Division during that year in comparison with the number of such contracts developed in any preceding year. During the fiscal year 1937 there was a decrease of only 593 in this figure despite the fact that authorization of the Soil Conservation Service to make field purchases in amounts not in excess of $1,000 at a number of its regional headquarters was expected to, and in fact did, transfer to the field a large volume of purchasing work involving the solicitation of competitive proposals. The estimated total money value of bid and acceptance contracts for the year was $13,533,801, and, since 8,223 transactions were involved, the average value of each procurement was approximately $1,646.

Recent legislation has affected bid work and procedure during the year. Foremost in point of importance is the act of June 30, 1936, "To provide conditions for the purchase of supplies and the making of contracts by the United States, and for other purposes," popularly known as the Walsh-Healey Act. Under its

provisions Federal funds may be employed for the purchase of materials, supplies, articles, and equipment in amounts in excess of $10,000 only from manufacturers or regular dealers therein who, in connection with the performance of contracts thereunder, pay their employees not less than the minimum prevailing wages for such work, employ no males under 16 years of age and no females under 18 years of age, permit no employees to work more than 8 hours in any 1 day or in excess of 40 hours in any 1 week, and who comply with the safety, sanitary, and factory inspection laws of the State in which the work or any part thereof is to be performed. The act prescribes penalties for breaches of these stipulations and conditions on the part of a contractor, and authorizes and directs the Secretary of Labor to administer the law and to make, amend, and rescind such rules and regulations as may be required in that connection. Hence, in advertising those supply requirements which are subject to the law, it is necessary to include extensive references thereto in the specifications and to exact pertinent certificates from all bidders. In addition, when an award has been made, the contracting officer must appropriately advise the Department of Labor and send to the contractor, for posting in his factory or plant, printed notices which inform his employees of their rights and privileges in connection with the performance of the contract.

Another law which has affected the bid work of the Department is the Bituminous Coal Act of 1937 (Public, No. 48, 75th Cong.), which establishes a National Bituminous Coal Commission and provides, in part, that no bituminous coal shall be purchased by the United States under competitive bids except that produced at mines where the employees of the producers have the right to organize and bargain collectively without restraint or coercion and are not discriminated against because of their exercise of such rights. The act also provides for prescription by the administering agency (the Bituminous Coal Commission) of minimum and maximum prices, marketing rules, and regulations. Specifications under which purchases of coal are to be made must therefore include appropriate references to this act.

During the year, also, the Procurement Division of the Treasury Department issued instructions to all Departments to include in their specifications for interstate transportation service references to the Motor Carrier Act, 1935 (Public, No. 255, 74th Cong.) and a form of certificate which each bidder must execute to show that the Interstate Commerce Commission has authorized him to operate motor vehicles over the route involved under the particular bid transaction. After awards have been made, the certificates of successful bidders are sent to the Interstate Commerce Commission.

Another special feature of procurement work has developed during the year under requirements of the Agricultural Adjustment Administration and the Soil Conservation Service for aerial surveys, such surveys having been found to afford an exceptionally effective basis for securing rapidly and on a very broad scale statistical data on crop distribution, soil erosion, and other farm conditions of particular interest and importance in certain major lines of the Department's work. Within the Department the necessity for each survey is carefully considered in advance by the land policy committee, and specifications are drawn in such form as to secure results which may be of use to other branches of the Department and other Federal agencies. Near the close of the year, the Procurement Division of the Treasury Department, also evidently recognizing the need for such coordination, promulgated a standard specification for the future use of all Departments. Forty-one contracts, aggregating approximately $2,000,000, were negotiated in the Department of Agriculture during the year. It may be added that, where adequate surveys have already been made by commercial concerns, purchases of prints from them are made by the Department in lieu of contracting for reflights of the areas already surveyed from the air.

AUTOMOTIVE EQUIPMENT

For the year there was a further increase in the authorizations for the purchase of motor-propelled passenger-carrying vehicles for use in the field work of the Department under regular—as distinguished from emergency—funds, the total figure rising to $349,268. For a general picture of the Department's requirements and use of automotive equipment, however, it is necessary to use a midyear tabulation, which took into account all such equipment in operation, whether purchased from regular or emergency funds. This showed in use in the Department on December 31, 1936, 4,166 passenger automobiles, 88 motor busses, 35,057 motor-trucks, tractor trucks, and tractors, 626 trailers and semitrailers, and 25 motorcycles, a total of 39,962 units.

TRAFFIC ACTIVITIES

With emergency activities still in operation on a broad scale throughout the Department during the year, the demands upon the Traffic Section for freight, express, parcel post, and passenger rates definitely exceeded, in the main, the already high figures for the preceding year. For the same reason an unusually large volume of work was required of the Section in connection with the many necessary diversions of shipments of field equipment in transit to destinations other than those for which it was originally intended; in the tracing of lost shipments; in the development of combination shipments in the interest of economy in long hauls; and in the adjustment with carriers of losses or damage to Government property in transit.

In the report for the fiscal year 1936 reference was made to the development of a passenger-tariff file and the use being made of it. During 1937 the maintenance of this service unit has involved the collection and incorporation in the file of approximately 10,000 additional tariffs to keep it up to date and otherwise complete. The effort involved has been amply justified, however, by the more dependable information thus made available as to itineraries, lowest available rates, schedules, connections, etc.

During the year free pick-up and delivery service on less-carload shipments of freight became generally available throughout the country, this service consisting of pick-up at the shipper's, or delivery at the consignee's, door, sidewalk, or platform, but not including any special service incident thereto, such as delivery to the upper floors of a building or other special handling. Generally speaking, free pick-up and delivery service is accorded by common carriers in their respective freight-classification territories on less-carload shipments moving under applicable minimum rates; and in instances where the shipper, or the consignee, performs the drayage on such shipments, a special rate allowance of 5 cents per hundredweight is made by the carrier. Where the freight rate falls below a designated minimum, moreover, the shipper, or consignee, may elect either to pay the difference between the actual rate and the designated minimum rate and secure free pick-up and delivery or to assume the drayage charges. By reason of the free pick-up and delivery service now performed by the rail carriers serving Washington, the Department has not negotiated a drayage contract for the fiscal year 1938, it being apparent that the free pick-up and delivery service will substantially meet the Department's drayage requirements at costs less than those which would accrue under a separate contract developed by the Department.

SUPPLY AND PURCHASE WORK

Supply service rendered the various bureaus of the Department by the Central Supply Section during the year has shown a marked improvement over the service of previous years. This result has been accomplished by transfer to the Central Supply Section of funds from the Agricultural Adjustment Administration and the Soil Conservation Service for the purchase of inventory, by transfer of stores stocks from the Resettlement Administration, by expedition of reimbursement of Central Supply through changed billing and operating procedures developed by the General Accounting Office and members of the staff of Central Supply, and by the securing of more suitable warehouse space. In changing the billing procedure, particular consideration was given bureau accounting and auditing requirements, the method adopted resulting in the efficient and expeditious handling of these accounts.

With the transfer of the Resettlement Administration to the Department, the Central Supply Section was designated to serve that agency in the manner it serves other bureaus. To initiate this service without impairing that already being rendered to other organizations of the Department, it was necessary, as already indicated, to increase the inventory of the Central Supply Section through transfer of a portion of Resettlement Administration stocks, leaving the Administration free to liquidate residual stocks by direct issue.

Table 18 shows large increases during the fiscal year 1936 in the number of purchase orders issued by the Central Supply Section, the money value involved, and the average money value per purchase order. For the fiscal year 1937 a measurable decline in each of these items will be noted. Both changes were largely the result of activities of the Soil Conservation Service. During 1936 large equipment and supply purchases were made for this Service, but during 1937 equipment needs were materially less and, in addition, authorizations granted regional procurement officers to make routine purchases within prescribed limitations were responsible for a considerable reduction in the volume of purchases handled by the Central Supply Section.

To coordinate more effectively the procedure for the distribution of printed forms with that for the issue of supplies generally, the stock of printed forms previously maintained by the Agricultural Adjustment Administration was taken over by the Central Supply Section on July 1, 1936, which then assumed distribution responsibility. Arrangements are now in progress for similar consolidation of the stock of printed forms maintained by the Soil Conservation Service.

The rigid control exercised by the Treasury Department with respect to the issuance of, and accounting for, Government tax-exemption certificates necessitated the development in the Division of an extensive procedure whereby the Department will be able to account for individual books of exemption certificates, Treasury control requiring semiannual bureau reports which, upon consolidation into a departmental report, must agree with the records of issue maintained by the Central Supply Section.

PROPERTY LISTS

Under general regulations of the Department the chief of the Division of Purchase, Sales, and Traffic is required to approve, before issue by bureau chiefs, lists of expendable, semiexpendable, and nonexpendable property. In order that the classification of the items of property in these lists may be as nearly uniform for all bureaus as is consistent with varying conditions of use, the Division has set up a card system which reflects a record of the approvals by the Division and indicates the reason for variations from standard classification whenever such variations are necessary. A number of bureau property lists have already been classified and the control record set up. The work of classifying initial bureau property lists is still in progress but well in advance of a contemplated installation of the uniform property accounting system now under consideration by the General Accounting Office. Experience thus far obtained in the work definitely indicates the need for uniform nomenclature in property descriptions which will be given more careful consideration upon completion of the classification work.

COORDINATION AND CONTACT WORK

The chief of the Division continued to function with the Procurement Division throughout the year as the general liaison officer and the technical liaison officer for the Department, as the representative of the Department on the Federal Standard Stock Catalog Committee, and as one of the five members of the special Federal Specifications Executive Committee. In the discharge of these duties it is necessary frequently to circularize the various bureaus of the Department in the dissemination of pertinent information and the promulgation of new or modified procedures. To facilitate subsequent reference to subject-matter circulars, a system of numbering, adopted early in the year, has proven very satisfactory. Between July 30, 1936, and June 30, 1937, 223 circulars were issued.

During the year the chief of the Central Supply Section of the Division was designated and has since functioned as a member of the technical committee charged with the evolution of Federal specifications on paper. No other changes occurred during the year in the interdepartmental coordination and contact work for which the Division is responsible.

UNIFORM PROJECT SYSTEM

An outline of the purposes and operation of the Department uniform project system established by the Secretary on January 7, 1935, is contained in the 1936 report of the Director of Finance.

During the year the work-project statements covering research work have been amplified, at the request of the Secretary, by the addition of a list of titles for the specific lines of research being carried on under each work project. Each line of research so listed has been termed a research line project. These lists of line projects will make available to the Secretary and his assistants information in convenient form which heretofore, because of the volume and diversity of research in the Department, has not been brought together for review.

A series of discussions of work being done by the bureaus and offices of the Department, as classified in projects of the uniform project system, were held during the year. These meetings were attended by the Secretary, Undersecretary, Assistant Secretary, and their assistants. Persons in charge of work under a particular financial project discussed the work informally with the group from the Secretary's Office, in many cases using visual material such as exhibits, charts, and slides.

NEW DEPARTMENT REGULATIONS

On April 23, 1936, the Secretary approved the new regulations of the Department, effective July 1, 1936. The Director of Finance was instructed by the Secretary to assume, for the time being, responsibility for the preparation of amendments required to meet changing conditions and to improve the scope and effectiveness of the regulations. In accordance with this designation, a total of 31 amendments were issued during the year. Of these 17 represented changes and 14 additions to the regulations as originally issued. It is to be hoped that the staff of the Department will continue to suggest additions and modifications which will make the regulations increasingly useful as a guide to better and more uniform procedure in departmental operations.

BUDGET AND FINANCE CIRCULARS AND MEMORANDA

Twenty-seven Budget and Finance circulars, with general distribution throughout the Department, and 55 budget and finance memoranda, with restricted distribution, were issued during the year. These issues were designed to provide for the dissemination or collection of information regarding fiscal matters.

ADVANCE PAYMENT FOR SERVICES AND FACILITIES AT FOREIGN HEADQUARTERS

The Agricultural Appropriation Act for the fiscal year 1938, under the item "Salaries, Office of the Secretary," contains the following new provision authorizing employees of the Department of Agriculture stationed in foreign countries to make advanced payments for rent and certain other facilities: "That with the approval of the Secretary of Agriculture employees of the Department of Agriculture stationed abroad may enter into leases for official quarters, for periods not exceeding 1 year, and may pay rent, telephone, subscriptions to publications, and other charges incident to the conduct of their offices and the discharge of their duties in advance, in any foreign country where custom or practice requires payment in advance." Heretofore authorization of this type has been applicable only to employees of the Foreign Agricultural Service, and thus was restricted to the staff of the Bureau of Agricultural Economics. The new legislation applies to all bureaus having employees stationed abroad.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - Price 10 cents

REPORT OF THE CHIEF OF THE FOOD AND DRUG ADMINISTRATION, 1937

United States Department of Agriculture,
Food and Drug Administration,
Washington, D. C., September 3, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I submit herewith the report of the Food and Drug Administration for the fiscal year ended June 30, 1937.

Sincerely yours,

W. G. Campbell, *Chief.*

CONTENTS

FOOD AND DRUGS ACT

ENFORCEMENT STATISTICS

The Federal Food and Drugs Act was enacted on June 30, 1906, and became effective on January 1, 1907. The fiscal year 1937, therefore, witnessed the completion of 30 years of enforcement operations. The last notice of judgment published during the year bears the serial number 26725, indicating that not less than this number of cases was terminated in the Federal courts in the 30-year period.

Tables summarizing seizures, criminal prosecutions, import actions, and the number and kind of samples collected and examined follow.

Table 1.—*Summary of interstate samples on which criminal prosecutions and seizures were based during the fiscal years 1936 and 1937*

Item	Criminal prosecutions		Seizures		Total	
	1936	1937	1936	1937	1936	1937
Foods	772	590	1,260	1,061	2,032	1,651
Drugs	368	350	223	263	591	613
Stock feeds	50	20	10	5	60	25
Total	1,190	960	1,493	1,329	2,683	2,289

The figures in the two columns headed "Criminal prosecutions" represent the number of samples from interstate shipments alleged to have been in violation of the statute and referred to the Solicitor of the Department as bases for criminal prosecutions against the responsible shippers. They do not coincide with the number of legal actions instituted or terminated during the year, since, in most instances, a number of alleged offenses by the same shipper are consolidated in one criminal prosecution action when it is referred to the courts.

TABLE 2.—*Import actions at port laboratories during 1936 and 1937*

Item	Inspected and refused entry		Inspected and released		Total	
	1936	1937	1936	1937	1936	1937
Foods	1,974	1,975	19,141	25,540	21,115	27,515
Drugs	1,089	1,359	6,429	6,347	7,518	7,706
Total	3,063	3,334	25,570	31,887	28,633	35,221

TABLE 3.—*Number and kind of samples collected and examined in 1936 and 1937*

Item	1936	1937	Item	1936	1937
Foods:			Drugs:		
Interstate samples	12,594	11,755	Interstate samples	8,316	7,024
Investigational samples	8,082	9,082	Investigational samples	258	512
Import samples	21,115	27,515	Import samples	7,518	7,706
Total	41,791	48,352	Total	16,092	15,242
			Total foods and drugs	57,883	63,594

Attention was given to the output of 10,962 manufacturers. Approximately 2,800 of these were responsible for some form of adulteration or misbranding. The figures in table 3 do not include inspections of about 192,000 cans of cream for buttermaking from interstate and intrastate sources made in cooperation with State and municipal officials.

TIME SPENT ON DIFFERENT TYPES OF VIOLATION

In 1937, 84.9 percent of the time of the food and drug force was occupied with the control of interstate traffic, and 15.1 percent with import traffic, as compared with 86.2 and 13.8 percent, respectively, in 1936, and 83.6 and 16.4 percent in 1935. The increase in time given to import problems is reflected in the increased number of inspections at the ports. A very definite effort is made annually to devote about 30 percent of the time of the field force to the drug project, including crude drugs, pharmaceuticals, proprietary preparations, and veterinary products. Actually, in 1937, 29.4 percent of the working time was given to this project.

Again as in 1936, approximately 19 percent of time was given to fruit products and 12 percent to vegetable products. This is a fairly constant figure from year to year because of the staple character of these articles. Fisheries products, including shellfish, required 9.1 percent, and dairy products 8.9 percent of the time of the field force. The remainder of the working time was divided as conditions required between the many classes of food products which invariably require some attention. Among these may be mentioned beverage products and flavors, cereals, chocolate and cocoa, coffee and tea, eggs, nuts, oils and fats, confectionery, spices and condiments, mineral waters, and stock feeds.

FOOD ADULTERATIONS INVOLVING PUBLIC HEALTH

The increasing concern with which the industry and State authorities are viewing the spray-residue problem and are adopting corrective measures at the source, accounts primarily for the small number of seizures of fruits and vegetables made because of excessive spray residue during the fiscal year.

The 125 seizures were distributed as follows:

	Seizures		Seizures
Apples	87	Pears	12
Cherries	14	Cabbage	2
Crab apples	3	Chili peppers	1
Currants	5	Green peppers	1

Fresh fruits account for 121 of these as contrasted with 140 in 1936, and 317 in 1935. Apple seizures in 1935 and 1936 totaled 299 and 106, respectively, as compared with 87 in 1937. Inspection and analytical work was necessarily continued at a level comparable with previous years. Samples of fresh fruits and vegetables totaling 5,213 from 3,566 producers and handlers were collected and analyzed for spray residue.

While complete statistics covering the amount of laboratory work done by various State control authorities are lacking, figures available show definitely that more than 86,000 such analyses were made, principally of apples, with a smaller number of pears. Lead arsenate is the most commonly used spray, but a definite increase in the use of fluorine sprays on apples occurred during the year. This served to complicate the control problem. However, since the use of fluorine sprays was attended with relatively little cleaning difficulty and was apparently fairly successful as a pest control, still greater increase in its employment is anticipated. As has been done with the arsenic and lead methods, the Administration's chemists cooperated in training State analysts in the newly developed and accurate method for the determination of fluorine as a spray residue.

Spray-residue-control operations, particularly on apples, will continue as a project of major importance. While organized State supervision has placed the control work largely on a routine basis in many sections, there still exists the necessity for cooperative assistance in such States, and for more extensive operations in those regions where State authorities have not as yet assumed full responsibility.

Celery, cabbage, peppers, and cauliflower, which have formerly given considerable concern because of spray residue, were in general free from objection. The impossibility of ignoring these products, and the serious hazard which the carelessness of an isolated grower can occasion, are well illustrated by one lot of cabbage made the basis of action during the year. This truck shipment, sampled jointly by Federal and District of Columbia inspectors on arrival in Washington, was found to contain, on the basis of the entire head, from 0.06 to 0.25 grain of arsenic per pound and from 0.12 to 0.55 grain of lead per pound. The outer leaves contained approximately three times these amounts. Investigation showed that this shipment came from a 23-acre field which had been dusted with lead arsenate 9 days before shipment. Inspection and analysis showed that a very large amount of poison still remained on much of the cabbage in the field, reaching a maximum of 1.6 grains of arsenic per pound, and 2.04 grains of lead per pound, or more than 100 times the accepted tolerance. State authorities took control of the remainder of the crop in the field and a criminal prosecution has been instituted against the shipper under the Federal act. Seizure of the cabbage sampled in Washington was effected by the District of Columbia authorities.

One of the most alarming examples of food adulteration involving a health hazard that has been encountered in some years was uncovered in April 1936. A case of illness, presumably due to the consumption of raisins, was reported in an eastern city. Analysis of samples, not only from the remaining material in the container which had supposedly caused the illness but of an unopened package bearing the same identifying marks, purchased at the same time, revealed a very high hydrocyanic acid content, 2,700 parts per million.

Hydrocyanic acid has been widely employed in fumigating incoming vessels from foreign lands as a health measure. It has also been used as a preliminary treatment on dried fruits, such as raisins, for the purpose of destroying insect infestation. While hydrocyanic acid gas is extremely dangerous, public health authorities have felt that in general the normal aeration processes following routine fumigation could be relied on to reduce the hydrocyanic acid content of the fumigated foods far below the danger point. This seemed to be confirmed by numerous chemical analyses of fumigated and subsequently aerated foods. This Administration's position has been that the use of a highly toxic fumigant on foods is always hazardous because of the possibility of human carelessness and the many unexplored possibilities of retention of the gas by the food under some conditions. The case of illness reported above and the

discovery of 2,700 parts per million of hydrocyanic acid in the sample appear to warrant this cautious attitude.

The offending product in this instance was immediately traced to its source and found to have been a part of a large stock of dried fruits held on the docks in the San Francisco area for several months during the prolonged maritime strike. At the termination of the strike the fruit was fumigated by commercial fumigating concerns because of the likelihood of insect infestation during the holding period. The fruit was allowed to remain in contact with hydrocyanic acid gas for varying periods.

All of the fruit subjected to this emergency fumigation was traced, and the field force was successful in locating practically all shipments. Thirty-five seizures, amounting to approximately 280,000 pounds of raisins, were made. The lot responsible for the illness which led to the discovery of this unusual form of adulteration contained the largest amount of hydrocyanic acid found in any of the specimens examined. Most of the others ranged between 200 and 800 parts per million. Except for one consignment of fig paste and one of dried currants, both of which were seized, no contamination of other dried-fruit products with dangerous amounts of hydrocyanic acid was discovered. Some 850 samples were examined in the course of this campaign. A thorough investigation of the fumigating practices in the individual packing houses and drying yards prior to shipment was also made. Of 104 producers visited, 15 admitted using hydrocyanic acid in fumigating fruit held for storage before packing. The industry has now discontinued the use of this fumigant. While the situation with respect to raisins is now well under control, the treatment of foodstuffs with toxic fumigants will obviously require further supervision by the Administration.

Continued attention was given to imported sardines, which in previous years have shown excessive lead contamination as a result either of the use of lead-coated utensils or possibly of exposure to solder in the cans. During the year, samples from 81 importations of sardines, totaling 17,660 cases, were analyzed for lead. Eighteen consignments, totaling about 3,700 cases, were detained. An attempt was made in one instance to reenter surreptitiously large quantities of Portuguese sardines which, because of excessive lead content, had been required to be exported following previous entry. The cans had been replaced in new cases to conceal their identity and the lot was consigned in transit to a dealer other than the intended consignee, in the evident hope that it would thus escape examination and identification. This lot, consisting of 500 cases valued at $7,500, was intercepted on arrival, seized under section 10 of the Food and Drugs Act, and subsequently destroyed after judgment of condemnation

Following the discovery last year of lead in maple products, an intensive educational campaign was undertaken in advance of the season to encourage producers to discontinue the use of terneplate sap buckets, buckets painted with lead paint, and storage tanks, evaporating pans, and other equipment with lead-soldered seams or mended with solder. Because there are thousands of individual producers it was essential to enlist the cooperation of State officials in the producing States. Their response was most gratifying. In practically every instance wide circulation was given by State agencies to announcements warning producers of the dangers of lead, explaining how lead gets into the products, and furnishing constructive suggestions as to how to prevent lead contamination. Some States furnished free laboratory services to producers. Upon the opening of the producing and shipping season, the field force made follow-up visits to producing areas, checked the equipment and procedures, and where necessary secured data on interstate shipments for later sampling at destination. These measures brought about a material improvement. However, there were obstreperous elements in the industry who minimized the objectionable character of lead. One buying agent in soliciting shipments from small operators widely advertised: "We pay no attention to lead ingredients, so you can use the same tools as ever." The aftermath of that announcement was the seizure of a consignment totaling 22,987 pounds of high-lead maple sirup shipped by this agent. There were also seized four other small lots of maple sirup aggregating only 262 gallons and four lots of maple sugar totaling 15,145 pounds.

Factory inspections reveal that the large concentrators and blenders are testing all receipts, and where high lead content is noted are removing it by appropriate treatment before repacking the goods for distribution. The objective is to continue work in this field with a view to eliminating exposure to lead in collecting and manufacturing processes.

Two cases involving accidental but highly dangerous lead contamination during shipment were encountered during the year. One resulted in the seizure of 548 sacks of 100 pounds each of lima beans, damaged, while in the hold of a ship, when a drum of a lead compound, litharge, was spilled on them. In the other case, 479 sacks, 100 pounds each, of rice had been similarly contaminated with lead chromate. There can be no excuse at any time for the careless storage of poisons in proximity to foods.

Last year's report recorded examination for lead of some 2,000 samples of different classes of foods from different localities. This work was continued as opportunity offered during 1937. With the exceptions already noted, lead contamination was not discovered. Products examined included powdered milk, canned shrimp, canned tomato products, and beer.

Eleven small lots of imported wines were refused admission because of the presence of excessive arsenic and three because of excessive fluorine.

The receipt of a complaint from the Middle West that a certain brand of candy bar contained broken glass led to an inspection of all outstanding shipments of this product. Only one lot was found contaminated with glass and this was seized. A criminal prosecution is pending against the manufacturer, who obviously had not adopted those precautionary measures in the factory which are essential to guard against contamination of this type.

The work on crab meat is reported under this heading because of the potential health hazard involved in the marketing of a polluted article. Three main areas produce crab meat in commercially important quantities. They are centered in the Chesapeake Bay, the South Atlantic coast, and the Gulf of Mexico and are within the territories, respectively, of the Baltimore, Atlanta, and New Orleans stations. All of these areas have received concentrated attention during the past 12-month period.

The Atlanta station had the advantage of operating with a trailer laboratory with full bacteriological equipment for the examination of samples in the field. With this laboratory manned by one sanitarian, one bacteriologist, and one inspector, operations on crab meat were begun in Florida in early March 1937 and continued northward through Georgia, South Carolina, and North Carolina as the season advanced through March, April, and May.

Conditions in the industry in the Atlanta territory showed considerable improvement, especially in Florida and the Carolinas, as a result of previous regulatory actions, voluntary corrective measures adopted by packers, and the activities of the State authorities. In the Chesapeake Bay area in the summer of 1936, conditions in some of the plants operated by individuals who had previously been prosecuted showed improvement, but other plants in this section were very little changed and polluted shipments were again found. Seventy-six manufacturers were given attention in the territory of the Baltimore station in 1937 as compared with 80 in 1936. Twenty-eight seizures were made as compared with 27 in 1936. In the Atlanta station territory, 50 packers were given attention in 1937 as compared with 51 the preceding year. Forty consignments were seized as compared with 54 in 1936.

The report for 1936 stated that the situation in the Gulf of Mexico area was less satisfactory than that found the preceding year and that plans had already been made to give intensive attention to the subject during the ensuing season. As a result of the campaign so planned, 38 packers were given attention and 38 seizures were accomplished. Officials of the producing States—Louisiana, Mississippi, and Alabama—are actively cooperating in requiring improved sanitary arrangements in the plants.

The development of an import traffic in shucked oysters from points on the west coast of Mexico to States in the Southwest focused attention upon the sanitary conditions surrounding the production and handling of this product. Since oysters grown in polluted waters are potential carriers of disease, it appeared desirable to investigate conditions at the source. This survey was particularly indicated in view of the shortcomings of bacteriological methods for objective examination which cannot be relied upon to reveal whether or not a given lot of oysters may be potentially dangerous. Through the offices of the Pan American Union arrangements were made with the Federal Department of Public Health of Mexico, the United States Public Health Service, and this Administration for a joint survey of the industry which centers at Guaymas in the State of Sonora. This survey disclosed that while a few practices needed improvement and reform, which were readily promised by Mexican officials, there was no reason to believe that oysters imported into the United States from Mexico are a menace to health.

FLOOD-DAMAGED FOODS

The annual report for 1936 referred to the problem presented to food officials by the extensive floods during that year. An even more disastrous flood visited the Ohio Valley in January and February 1937. The flood area extended along the Ohio River for some hundreds of miles from Huntington, W. Va., to Cairo, Ill. Large areas along the Mississippi were likewise inundated, but the principal stocks of foods and drugs which were covered with polluted floodwaters were found in the cities and towns along the Ohio River and some of its tributaries. The sudden and unexpected rise of floodwaters to unprecedented levels prevented movement of merchandise from the danger zone.

The Food and Drug Administration assigned 44 members of its personnel to serve with and assist State health and food officials of West Virginia, Ohio, Kentucky, Indiana, and Illinois, and the authorities in inundated cities and towns. Local officials contributed approximately 80 men, including 10 inspectors from the Pennsylvania Food and Drug Department. Personnel was assigned to assist by the Works Progress Administration, State and city police, State militia, United States Bureau of Animal Industry, United States Bureau of Entomology and Plant Quarantine, Ohio State Bureau of Animal Industry, United States Public Health Service, and other organizations. The entire Food and Drug Administration force was integrated with that of other agencies and the work was undertaken in each community as soon as the floodwaters receded sufficiently to permit operations. Even while the cities were actually under water, experienced State or Federal inspectors made preliminary surveys and perfected the inspection organization. In some areas salvage operators and scavengers appeared on the scene as early as the food and drug inspectors.

The general plan involved an orderly and immediate destruction of all foods and drugs which had become contaminated with floodwaters, and the reconditioning, under supervision, of commodities packed in hermetically sealed containers, which present no public health or hygienic problem after proper cleaning and sterilization of the containers. Typical of the substances which were required to be destroyed immediately were potatoes, flour, fresh vegetables, meats, and butter. In some instances grains and other perishable commodities were permitted to be completely denatured and subsequently used for technical or animal-feeding purposes. Some idea of the scope of these inspection activities will be given by the following figures:

	Number
Wholesale food establishments	410
Retail food establishments	997
Wholesale drug establishments	18
Retail drug establishments	251
Solid carloads on tracks	434
Less than carloads on tracks	540

	Tons
Amount of food products condemned or required to be cleaned	74,584
Amount of drugs condemned or required to be cleaned	141

The foods and drugs handled, it is estimated, would have been sufficient to maintain a city of 200,000 population for 1 year.

The orderly disposition of the condemned merchandise presented a major problem because the disposal plants of most communities were flooded. It was necessary either to bury or burn the condemned articles immediately so that they could not be reached by looters, or to post a guard until this could be done. Repeated instances arose where prompt action was required to prevent the removal of flood-damaged merchandise for subsequent sale. In practically all instances the wholesalers and retailers, who had suffered tremendous damage, cooperated willingly with the authorities. The plan did not involve formal seizure of the merchandise. The vast volume of commodities made this impracticable, and in any event, the ready cooperation of dealers made formal action unnecessary.

FOOD POISONING

Sixty-seven alleged food-poisoning cases were investigated. In six instances the outbreaks were small epidemics occurring at a picnic, a labor camp, a National Guard encampment, a hospital, a high school, and a home for the aged. They involved groups ranging from 20 to 90 people. In the remaining

cases the victims comprised only the members of a family or a small party. The cases were rather widely distributed in 30 States in eastern, midwestern, and western areas.

The symptoms in 44 of the outbreaks, as described in official reports, were those of gastroenteritis, commonly although erroneously referred to as "ptomaine poisoning." This type of food poisoning is frequently traced to articles extensively handled during preparation and made up of ingredients that offer favorable environment for bacterial development if not properly preserved. It is, therefore, significant that in 25 of the alleged cases of gastroenteritis investigated, suspicion was directed toward salads, cold meats, pastries containing cream fillings, or sandwiches filled with meat or fish, all of which require very careful handling and refrigeration.

There is sound reason to believe that many cases reported in the press or diagnosed hastily as food poisoning were in fact due to other causes than food. Two cases originally reported as food poisoning were later held to be due to the inhalation of toxic gases escaping from defective electric refrigerators; one case, involving two children, was apparently meningitis, and another, intestinal influenza.

Samples for examination by the bacteriologists, chemists, and toxicologists of the Administration were collected in 32 outbreaks. In the other 35 cases either no sample of suspected food was available, or competent investigation was made by State or municipal officials, or the evidence that food was not involved was so conclusive that no collection of samples was necessary. Of the samples examined, only six yielded some evidence that the suspected product was actually the cause of illness. In five cases bacteria capable of causing illness were isolated, and in one case the presence of a toxic chemical compound was disclosed. In four of the five cases yielding positive bacteriological evidence, the organisms isolated as the possible cause of illness were cocci, the organism in the fifth case being *Clostridium botulinum*, as mentioned in the following paragraph. In two instances, the product involved was a cooked ham, which was, no doubt, contaminated after cooking on the premises where served. Also, in two instances the incriminated product was imported cheese. In all four cases, through cooperation with local health authorities, the offending products were confiscated and destroyed.

Four cases reported as botulism, in each of which there were fatalities, were investigated. Of these, three cases, all occurring in Western States, were due to underprocessed home-canned vegetables. Samples from three of these cases were submitted to the Administration. From one of the samples collected in an outbreak due to home-canned beans, the toxin and spores of type A *C. botulinum* were found. Continuing the good record of several years no authentic case of botulism from American commercially canned food was reported.

Early in the fiscal year suspicion was directed toward imported canned clams as the cause of death from botulism in California. No sample of the material actually consumed by the victims was available, but the recovery by the State health laboratory of the spores of *C. botulinum* from an empty can obtained on the premises of the deceased provided some evidence incriminating the canned clams. This class of products, which had been constantly subjected to careful import control, was thereafter examined with renewed vigor. A general survey was made of all stocks outstanding in the markets of this country. As a result, 126 samples of imported canned clams, totaling 2,370 individual cans, were examined bacteriologically. No evidence of the presence of the spores or toxin of *C. botulinum* was found. Some defects in processing, with resulting spoilage, were detected and appropriate action was taken to deny entry of such goods into this country. Foreign canners of this product have, within the year, taken steps to improve canning methods and this has been reflected in the condition of shipments now being offered for importation.

A food-poisoning case attributable to hydrocyanic acid residues in raisins has been discussed earlier in this report.

FOOD ADULTERATIONS INVOLVING FILTH AND DECOMPOSITION

The equivalent of more than 192,000 8-gallon cans of cream from intrastate and interstate sources was examined jointly by State and Federal officers, as compared with 200,000 in 1935 and 176,000 in 1936, resulting in the condemnation through State or Federal action of 5,410 cans. On the basis of

actual figures this shows a slight improvement over 1936 and material improvement over 1935. The inspectors report, however, that the condemned cream in general is not nearly so bad as it was in 1935 when the cream-improvement campaign was inaugurated despite the fact that, as a result of experience gained in preceding years, more attention has been devoted to areas known to be producing the greater volumes of questionable cream.

Other dairy products given attention under this heading include cheese and butter. Seizures of butter on the ground of objectionable extraneous material were less than in previous years, amounting to 21 as compared with 27 in 1936 and 43 in 1935. Limburger cheese, which was responsible for 10 seizure actions in 1936 on the basis of filth, produced no legal actions in 1937. Failure to uncover actionable limburger cheese shipments during 1937 is possibly due more to the general use of filters in the course of manufacture, to remove evidences of insect contamination, than to improvement in sanitary conditions. As is quite frequently the case in regulatory operations, the development of improved methods of objective analysis by the staff laboratories of the Administration must precede more extensive corrective activities.

It will be convenient to discuss the work on tomato products on the basis of the activities of each of the three inspection districts. The eastern district gave attention to 180 packers of canned tomatoes, none of whom was found to be packing decomposed or insect-infested material. Attention was also given to 107 manufacturers of other tomato products. The output of 24 of these exhibited evidences of violations, principally the use of moldy raw stock, improperly trimmed. A total of 149 official samples was examined, resulting in the seizure of 27 lots of tomato paste or puree, aggregating 1,377 cases, and 13 lots of tomato juice, aggregating 5,639 cases. All of these seizures were because of moldy material except one lot of 1,780 cases of tomato juice which had spoiled by fermentation.

In the central district seasonal conditions were unusually good last year for the production of tomatoes free from excessive amounts of rot. Mold, therefore, played a minor role as a source of adulteration. In 1936 approximately 25 percent of the samples collected warranted seizure action, principally because of decomposed material. These samples were selectively obtained from those manufacturers believed to be exercising inadequate control. In 1937 about 11 percent of the samples collected showed moldy material. Insect infestation, however, led to a considerable number of actions in 1937 as compared with 1936 when very little infestation was found. From 275 samples, representing the output of 166 manufacturers, 66 seizure actions resulted, two-thirds of which were based on worm infestation. While this record is less favorable than in 1936 when a total of only 46 seizures was made in this region, it is materially better than in 1935 when 168 seizures were effected.

The western district packers have developed effective factory methods for eliminating worm-infested fruit. On the whole this area produced a satisfactory product. One section only in the western district was responsible for practically all the regulatory actions based on wormy fruit. This was in the territory around Los Angeles where conditions were such that 34 seizures of objectionable material were made.

During the year there were packed in southern California more than 2,600,000 cases of canned tuna, the largest pack ever produced. Much of the raw tuna is imported and arrives in frozen condition. Adequate examination cannot be made until it has thawed. As the only practicable arrangement for supervising this material, packers are permitted to thaw the fish and make preliminary preparation for packing, after which it is inspected. The sound material is then canned and finally samples of the canned product are examined. The ultimate clearance for import is thus effected only after examination of the cans has demonstrated that the material is satisfactory. Nine million pounds of raw tuna were offered for entry in the course of the year, in 133 lots. With the exception of one small lot which was never unloaded, all were detained and rigidly sorted, the objectionable material, amounting to slightly more than 1,000,000 pounds, being destroyed. One hundred and thirty-two lots of imported canned tuna, totaling 754,000 pounds were inspected and 7 lots totaling 14,000 pounds were refused entry. Examination of 62 samples representing 15 domestic manufacturers of canned tuna resulted in 5 seizure actions directed against the products of 3 manufacturers.

Last season's pack of canned salmon was approximately 8 million cases. Inspectors from the western district visited all canning areas except the extreme

western portion of the Aleutian Peninsula. Attention was given to the output of 141 packers. A total of 1,851 samples was collected and examined. Ninety-four consignments were seized as compared with 145 consignments in 1936. In Alaska particularly, considerable improvement has been made in the handling of salmon, tending to reduce the time interval between catching and packing. Most packers have introduced some system of control over fishing boats in order to insure that all deliveries are received within 24 hours after catching. A large percentage of the fish are taken from traps under the complete control of the canner. Notwithstanding material improvements, the number of cases in which action must be taken is still entirely too high. While certain areas suffered unusually hot weather, this by no means accounted for all of the decomposition found. Further material improvement must be made in the handling of salmon before we may expect a satisfactory pack.

Surveillance of the salmon industry presents problems of peculiar difficulty. The bulk of the industry operates its canneries in Alaska at points which can be visited only rarely, if at all, by inspectors of the Food and Drug Administration. The short season, the remoteness of the canneries, and various physical difficulties too often emphasize speed rather than care in the packing of the product. Actual examination by the Food and Drug Administration cannot be undertaken in an extensive way until the canned product is transported to the States. The Alaska pack is shipped to Washington, Oregon, and California ports for storage and subsequent distribution. Nearly all of the pack arrives unlabeled. The magnitude of the task confronting laboratories of the Administration in the inspection of the material is illustrated by the fact that during a period of 12 days there were delivered to the port of Seattle approximately 1,750,000 cases of canned salmon. Early sales were unusually large and the material passed very rapidly through the warehouses both at Seattle and San Francisco, where nearly a million cases were handled.

The inspection force must procure and examine as expeditiously as possible, representative samples from those lots of salmon which there is reason to believe may contain objectionable fish. It is the almost universal practice of each canner to identify his individual cans by code marks which are indicative of the day of packing and the cannery where packed. Not infrequently an even shorter period than a day is represented by one code mark. At the present time sufficient care is exercised in the average cannery, as the result of seizures and prosecutions, to eliminate all but occasional decomposed fish from the pack. Consequently it is unusual for more than a comparatively small fraction of the number of cans in any one code to contain decomposed material. The majority of the codes are likely to be entirely free from any evidences of decomposition. Unfortunately, in the course of transporting cases of salmon from the Alaska canneries to the warehouses in the States, it most frequently happens that the codes in any one shipment become inextricably mixed. Where a consignment contains a number of codes and samples show some decomposed fish, it is necessary to seize the entire consignment. After the entry of a court decree it is the packer's responsibility, under supervision, to sort out the good codes from the bad and then further to examine the bad codes for the purpose of separating and destroying those individual cans which contain decomposed material. This is accomplished by heating and puncturing the cans. The unmistakable odor of spoilage is amply evident in the objectionable cans and these are destroyed. The good ones are resealed, resterilized or, as it is technically called, reprocessed, and then released in conformity with the court decree. Because the resterilization process softens the fish so that, while entirely suitable for food purposes, it has not the firm quality of fish subjected to only one sterilization process, the courts now usually require that such recooked salmon be labeled plainly "Reprocessed." To maintain surveillance over large numbers of codes which contain no bad fish but are mingled with lots that do, imposes a burden on the Government which should, if possible, be obviated. Steps were taken during the fiscal year to effect an arrangement with the salmon industry whereby records would be kept of individual codes and these codes would be so segregated that seizure could be made of the objectionable code alone rather than of the entire number of codes comprising the shipment.

The foregoing will explain why, in spite of the fact that approximately 200,000 cases of salmon were seized, the actual percentage of bad salmon in these seized lots was comparatively low. Under the new plan it is anticipated that smaller lots will be seized but that the limited number of codes which

do contain objectionable fish will be very much more effectively handled with a consequent improvement of the public protection afforded.

One million two hundred and thirteen thousand cases of mackerel, almost a half million cases below last year's pack, were canned during the year. Although many samples were examined, there was no occasion to take action against this product.

The California sardine pack totalled over 3 million cases. One hundred samples representing the output of 25 manufacturers were examined but no regulatory action was required.

The central and eastern districts continue to be confronted with the problem of controlling importations of fresh fish, particularly tullibees and whitefish from Canadian sources, infested with parasitic worms. One thousand, six hundred and seventeen lots, aggregating 8,695,000 pounds, were examined and 174 lots, totaling 798,000 pounds, were detained. While in the eastern district there has been some reduction in the amount of fish of this type offered for importation, there has been a slight increase in central district importations. No material improvement appears to have occurred in the character of the product.

Increased difficulties were encountered during the year in intercepting shipments because of bootleg methods adopted by certain elements of the trade in an effort to circumvent inspection. Because of this, some 18 seizures aggregating nearly 50,000 pounds of tullibees were effected in addition to the import detentions reported.

An unprecedented freeze in California early in 1937 destroyed a large part of the Washington Navel orange crop and reduced the Valencia crop to far below normal. The western district, in cooperation with State officials, maintained constant surveillance over packing houses. The State enforced its regulations with vigor and was in large measure able to prevent the shipment of frost-damaged fruit. It was necessary to make only three seizures of interstate consignments of frost-damaged material. Too much cannot be said in commendation of the attitude of State officers who handle effectively within their own boundaries, types of food products which should not be distributed.

Examination was made of samples representing 281,616,000 pounds of imported cocoa beans, which is about 45 percent of the total amount entered. Forty-four lots, totaling 8,752,000 pounds, or approximately 3 percent of the total poundage examined, were detained because of mold or other forms of decomposition and filth. The amount of detentions was greater than in 1936 and the percentage rejected jumped from 0.16 to 3 percent.

Twenty-three seizures of nuts were made, representing the output of 17 shippers. The majority of the seizures were based on rancidity, worminess, or other types of filth or decomposition. Importations to the extent of 1,169 lots totaling 25,864,000 pounds were inspected and 100 lots aggregating 625,000 pounds were refused admission or detained pending sorting. This is to be compared with 866 lots, amounting to slightly more than 21 million pounds, examined last year, of which 32 lots, totaling 689,000 pounds, were refused entry.

Imported condimental seeds continue to represent an important inspection problem at the ports. Annual importations in the eastern district amounted to more than 260 million pounds. One thousand nine hundred and seventy-three lots, totaling 36 million pounds, were inspected. Three hundred and nineteen lots, totaling 4,684,000 pounds, were detained principally because of the presence of insects and rodent excreta or, in the case of nutmegs, mold and worminess. While some slight improvement in the quality of spices is noted, the situation is far from satisfactory. Oilseeds, amounting to something over 8 million pounds, principally sesame seeds, were inspected in the western district and 3,538,000 pounds detained.

Work on frozen eggs revealed only seven decomposed lots. These were seized and criminal prosecutions were directed against the shippers. One of these lots was produced by the unique method of crushing the shells after the normal commercial preparation of yolks, whites, or mixed eggs, and centrifuging the crushed shell to separate the residue of adhering egg material. The resultant product was essentially decomposed egg white containing small amounts of yolk. Approximately 1,500 cans were seized in December 1936. Criminal prosecution followed, with a plea of guilty and a fine of $200 in June 1937.

After a lull of several years, renewed traffic in the type of shell eggs known as incubator rejects developed. These eggs, which ordinarily have been incu-

bated for several weeks and then rejected as infertile or because the embryo has died, were going to breakers for the ostensible purpose of preparing so-called tanners' yolks for leather manufacturing. There was considerable evidence, however, that the product might enter food channels. Five comparatively small lots were seized. Since traffic in incubator rejects, both in the shell and after breaking and freezing, is largely by truck shipments through bootleg channels, the procurement of interstate records is extremely difficult. The work was therefore carried out in cooperation with State officials who not only gave valuable assistance but succeeded in confiscating a number of lots under State laws.

Import examination was made of 399 lots, totaling 62,268,000 pounds of dates. Seventy-six lots, amounting to 2,226,000 pounds or 3.6 percent, were detained as unfit for food. Three hundred and sixty-nine lots of imported figs, aggregating 6,442,000 pounds, were examined and 60 lots amounting to 608,000 pounds detained. The percentage detained was therefore about 9.4 percent, or about twice that of last year, when 321,000 pounds out of offerings of 6,900,000 pounds were rejected.

FOOD VIOLATIONS INVOLVING ECONOMIC CHEATS

No consumer cheat is so profitable potentially as adulteration with water, and surprisingly it is one of the most difficult to detect and deal with under the law. Nothing can be said in defense of a manufacturer who sells water to consumers at food prices. The technical difficulty lies in the fact that water is a natural ingredient of practically all foods and a normal amount of water is not an adulteration. The establishment in a court of law that a food contains excessive water and is therefore adulterated is a formidable legal problem. There is a crying need for legislative authority to set up legal standards for foods under which definite limits for water content can be established.

The wide variety of foods which lend themselves to this form of cheat can be illustrated by merely cataloging the products against which action was instituted in 1937, because of adulterations based essentially on the partial substitution of water for the food. Statisticians might easily calculate that this phase of law enforcement alone saves consumers many times the total amount appropriated for enforcement of the statute. During the year seizures were directed against such varied products as butter, jams and preserves, orange beverages, frozen eggs, tomato juice, and fresh oysters, in which the substitution of water was an important element of the violation.

Sixty-one shipments of butter involving economic violations such as short weight, short fat (excess water), or both, were seized and 29 prosecutions were instituted. More attention will be given to this form of economic cheat during the current year.

Jellies and jams continue to require much consideration. The offense is again essentially a substitution of water for food, although in some instances excessive sugar is substituted for part of the expected amount of fruit. The violations prevalent in the preserve industry were discussed in some detail in the last annual report. During the year 24 seizures were directed against adulterated and misbranded jams, jellies, and preserves, and 142 samples were made the basis of criminal prosecutions against 14 manufacturers.

A somewhat unusual fraud was revealed in the discovery that a large spice shipper in France was systematically extracting volatile oil from marjoram and thyme leaves and then mixing 20 to 50 percent of the exhausted leaves with good leaves for shipments to the United States. Following this discovery complete coverage was given to imported thyme and marjoram but the adulteration was found to be restricted to the products of only one foreign shipper. Entry was refused to five lots of marjoram aggregating 22,219 pounds, and five of thyme amounting to 39,889 pounds. In addition, seizure was effected of four lots, totaling nearly 10,000 pounds, of these spices which were part of entries made prior to the discovery of the adulteration.

The sale of coffee chaff as "coffee screenings" resulted in prosecution of one manufacturer. Coffee chaff is a valueless waste product. It was purchased from coffee roasters by the manufacturer ostensibly to be used for industrial purposes. It was then molded into granules resembling roasted ground coffee and sold to coffee dealers under representations which led them to accept it as suitable for mixing with coffee. Such worthless products have no place in food.

McNARY-MAPES AMENDMENT

Sixty-three seizures were directed against canned foods which failed to meet the standards of quality, condition, or fill of container set up under the McNary-Mapes amendment to the Food and Drugs Act and were not labeled to show their substandard character. The seizures included 12 lots of cherries, 4 of peaches, 2 of pears, 1 of mixed apricots and peaches, 33 of peas, and 11 of tomatoes.

SEA-FOOD AMENDMENT

Inspection service under the sea-food amendment was continued during the year in 50 shrimp canneries as compared with 39 in 1936. Eight hundred and eighty-seven thousand five hundred and sixty-seven cases of inspected canned shrimp were produced. About 85,000 cases were packed in uninspected plants. Since the shrimp catch was lighter this year than last, the inspected pack was about 80,000 cases less than last year.

For the first time since the service was established in 1934 Congress appropriated funds to defray part of the cost of the service. The amount thus made available was $40,000. In addition to this, the packers paid fees totaling $58,599.46. The cost of inspection for each can of shrimp was a trifle less than one-quarter cent.

During the year, inspection was withdrawn from one cannery for failure to make the required advance payment of fees.

A fully equipped bacteriological laboratory was installed in the New Orleans station in which all samples collected for checking the sterility of the canned product were examined. This relieved the bacteriological laboratory of the Food Division in Washington of a large amount of routine work which it had been called upon to do in previous years.

Because of shortage in pack, practically no stocks were left over in canners' warehouses at the end of the packing season.

ACTIONS ON DRUGS

False and fraudulent therapeutic claims on medicines for human use accounted for the institution of criminal prosecutions against 52 defendants and 161 seizures representing the products of 124 shippers. In the course of the year nearly 1,500 samples of such products, the output of 897 manufacturers, were given attention including usually both chemical analysis and a critical review of the therapeutic claims borne by the labeling. Veterinary remedies similarly misbranded gave rise to 16 seizures involving the products of 12 manufacturers and prosecutions against 11 manufacturers. A total of 238 samples of veterinary preparations, the output of 134 manufacturers, was given attention.

Chemicals and preparations purporting to comply with requirements of the United States Pharmacopoeia accounted for 32 seizures and the institution of criminal prosecutions against 35 manufacturers. Substandard glandular preparations claiming to be U. S. P. resulted in criminal action against three manufacturers. The total number of samples of products purporting to be of pharmacopoeial quality amounted to 2,112 and represented the products of 475 manufacturers.

Chemicals and preparations purporting to be of National Formulary quality accounted for 3 seizures and criminal action against 21 manufacturers. Glandular preparations which failed to meet the National Formulary requirements resulted in one seizure and one criminal prosecution. A total of 1,460 samples of National Formulary preparations, representing 190 manufacturers, was examined. A grand total of 3,572 samples of official preparations resulted in the institution of legal action in the case of 154 samples from 76 manufacturers. In 1936, 3,936 samples of official preparations were examined, resulting in 77 legal actions involving 39 manufacturers.

As usual, anesthetic ether was extensively sampled. Individual containers totaled 2,689 from 227 shipments, of which 219 containers or 8.1 percent failed to meet the pharmacopoeial requirements. As a result, 18 consignments were seized. In 1936, 24 cans out of 2,246 individual containers, or 1 percent, failed to meet the pharmacopoeial tests and 9 shipments were seized.

As was the case last year, only three manufacturers are producing anesthetic ether in this country and in both years two of these were responsible for all the substandard goods. The new United States Pharmacopoeia XI became effective June 1, 1936. It specified a more delicate test for aldehyde than that

in the tenth edition of the pharmacopoeia applicable in previous years. This alone, however, does not explain the increased number of substandard cans found in 1937, since only 24 containers out of 219 were objectionable because of high aldehyde alone. Twenty cans were objectionable exclusively because of the presence of iron rust. Thirty-four were from consignments shipped a year or more before sampling and may have deteriorated. The remaining objectionable cans, amounting to 141 or 5.2 percent, however, showed excess peroxide by the U. S. P. test which is essentially that applied in previous years. Some of these also showed the presence of aldehyde.

Unofficial chemicals and preparations to the number of 1,793, representing 347 manufacturers, were examined, and 93 were made the basis of legal actions. These included criminal prosecutions against 16 manufacturers and 9 seizures involving the output of 6 manufacturers. Eighty-five unofficial glandular preparations were examined, representing the output of 32 manufacturers. Ten of these samples from five manufacturers resulted in legal action. Other products which led to actions in the drug field included absorbent cotton and surgical dressings, alcohol rubs, antiseptics, and reducing preparations.

Some further discussion of activities in the drug field will be found in the sections on Bacteriological Investigations of Foods and Drugs and Comments on Court Cases. It is worth while to mention here, however, two instances illustrating the extreme carelessness which characterizes the operations of some of the poorly equipped pharmaceutical manufacturers. One criminal prosecution, terminated near the end of the year with a plea of nolo contendere and a fine of $250 and costs, involved nitroglycerin tablets intended for hypodermic use and labeled as containing not over one-hundredth of a grain of nitroglycerin. Analysis showed a shortage of approximately 86 percent of the medicinal ingredients. In addition the chemists found a material amount of ammonium nitrate in the tablets. Investigation developed that the manufacturer was not using nitroglycerin purified for drug purposes but was purchasing ordinary dynamite and extracting it with alcohol to obtain the nitroglycerin. This particular grade of dynamite, which is known as 60 percent Extra Strength Dynamite, is made from about 20 percent of nitroglycerin oil and 57 percent of ammonium nitrate. The analysis showed that the manufacturer was in fact incorporating about three times as much ammonium nitrate as nitroglycerin in the tablets.

In another case in which criminal action has been instituted, approximately 25 samples of the manufacturer's ampuls containing important drugs were analyzed and shortages were found in the potent ingredient ranging from 7 to 82 percent, most of them ranging between 50 and 82 percent. One sample showed an excess of active ingredient of 175 percent. There can be no excuse for the continuance in business of a manufacturer who has so little control over his manufacturing operations.

BACTERIOLOGICAL STUDIES OF FOODS AND DRUGS

Reference has been made in the section on food poisoning to the work of the bacteriological unit in that field. Some idea of the magnitude of the bacteriological investigations and related studies undertaken in connection with Food and Drugs Act enforcement is conveyed by the record of samples examined during the year by the bacteriological section. A total of 652 samples of domestic products, containing 12,326 subdivisions, and 279 import products involving 4,652 subdivisions was tested. These included not only samples in suspected food-poisoning cases but numerous foods sampled because of suspicion or knowledge that filth or decomposition detectable by bacteriological examination was involved. Included also were many samples of canned fish products, suspected of decomposition, to be examined organoleptically. The large number of specimens of crab meat examined in the field investigation on that project is not included in these totals. They do include, however, many samples of ampuls, bandages, surgical cotton, and the like, collected under the drug project and examined for sterility.

Ten types of sutures from 80 shipments made by 14 different manufacturers were examined bacteriologically. Samples from two shipments, both by the same manufacturer, were found unsterile and were seized. Over 99 percent of all the sutures examined were sterile. One hundred and fifty-two samples of ampul products, totaling 787 separate ampuls from lots of American manufacture and 2 samples of 16 ampuls from lots of foreign manufacture were examined. The samples included 57 different products, ranging from such

simple preparations as distilled water, glucose solution, and physiological salt solution to drugs of complex chemical structure. The output of 21 different producers was covered. Three seizures, representing nine lots of phenobarbital sodium in ampuls were made because the product was contaminated with bacteria. All were from the output of one manufacturer. The ampuls found to be nonsterile amounted to approximately 4 percent of all the units examined during the year.

A new line of work, the bacteriological examination of bandages, adhesive tape, absorbent cotton, and other surgical dressings, was inaugurated just before the beginning of the year. Continuing this work, 112 samples of products manufactured or packed by 30 different companies were examined bacteriologically. Twenty-nine shipments of absorbent-cotton bandages or surgical dressings from 20 manufacturers were seized. Discussion of a contested case on one of these actions will be found under Comments on Court Cases.

Attention was given during the year to a number of acidophilus products with the result that several misbranded and adulterated preparations were seized and one criminal prosecution instituted.

In addition to the directly regulatory activities of the bacteriological unit, studies have been carried on with a view to the development of methods for the identification of bacterial flora as an index of filth and decomposition in such products as cream and butter, fish products, and shelled nut meats.

VITAMIN TESTS

Last year attention was called to the importance of controlling the quality of imported cod-liver oil intended for animal feeding. Since most of the cod-liver oil used in this country is of foreign origin, examinations at the port of entry effect better control than an equal number of assays on interstate shipments. During the year samples from 256 shipments representing 880,687 gallons of imported oil were assayed for vitamin D. One hundred and fifty-eight shipments (586,023 gallons) were found to comply with the requirements of the United States Pharmacopoeia. Eighty-three shipments (283,111 gallons) were below the pharmacopoeial requirement of 85 units of vitamin D per gram and were refused entry. The remaining 15 shipments (29,553 gallons) contained less vitamin D than claimed on their labels, and were permitted entry for relabeling. While these figures show that 32.1 percent of the volume of the oil examined was refused entry, recent examinations indicate an improved situation. The oil refused entry would have been sufficient, if of standard quality, to serve as a source of vitamin D for more than 100,000 tons of poultry feed.

Fifty-four biological assays were made on 34 samples from interstate shipments of miscellaneous vitamin products. Of these samples 24 were deficient in one or more of the vitamins and legal action was instituted. The large proportion of samples found illegal does not reflect accurately the validity of vitamin claims for products on the market. Limited facilities dictated a policy of confining vitamin tests largely to those products most likely to undergo deterioration during manufacture or storage.

PHARMACOLOGICAL INVESTIGATIONS

The annual report for 1935 announced the establishment of a Division of Pharmacology. In explaining the varied duties assigned to this division, the following statement, among others, was made:

> Studies must be made of the chronic effects of the repeated ingestion in foods of a number of substances known to occur as impurities. Lead and arsenic may be cited as illustrations. In spite of much work in many places there exists no complete body of pharmacological evidence on which tolerances for these substances in food can be established with entire satisfaction. Some authorities consider that the existing tolerances are too lenient, others that they are too severe. The majority who are competent to speak on the subject believe that the public health is reasonably protected by the tolerances now in effect, although they insist that unremitting efforts should be continued to reduce toxic impurities to a minimum in foods. It is universally recognized that more extensive scientific work is highly necessary as a basis for establishing and enforcing definite tolerances.
>
> The recognition of the toxicity of certain poisonous substances now commonly used as insecticidal sprays on growing crops has lead to proposals to substitute many other types of insecticides alleged to be less toxic to the consumer. As new spray substances are proposed it is highly necessary to study their toxicity so that the Administration can adopt a proper position from the law-enforcing standpoint.

A comprehensive program of research on the toxicity of lead and arsenic in the amounts normally occurring in spray residues was initiated in the early part of the fiscal year 1936. The annual report for that year made the statement:

During the present year new laboratories and animal quarters have been equipped for this division (pharmacology) and work initiated particularly along the lines of the chronic toxicity of small amounts of lead and arsenic. Since this is a long-time study, reports of findings to date would be premature.

This work was continued intensively during the fiscal year 1937. For the purpose of checking the sufficiency of the program, the adequacy of the equipment and technique employed, and the competency of the scientific personnel engaged, the Secretary of Agriculture appealed early in the year to the National Academy of Sciences to appoint an impartial committee of scientists from that organization to counsel with the Food and Drug Administration's Division of Pharmacology. This committee, consisting of five nationally known scientists, was duly appointed, made a comprehensive study of the work, and filed a report early in January commending the program, the plan of operations, the technique and personnel engaged in the work, and making certain constructive recommendations for expansion of the investigation and improvement along various lines. Coordinately with the pursuit of the program as originally outlined, plans were being made to adopt in full the committee's recommendations. The Agricultural Appropriation Act for the fiscal year ending June 30, 1938, however, contained the following proviso:

Provided further, That no part of the funds appropriated by this act shall be used for laboratory investigations to determine the possibly harmful effects on human beings of spray insecticides on fruits and vegetables.

Under the mandatory terms of this proviso the 2-year research program on the toxicology of arsenic and lead, which it had been planned to continue for a period of 2 or 3 years longer in order to obtain the scientific data essential for a satisfactory solution of the problem, was terminated abruptly on June 30, 1937, and all experimental animals were destroyed.

Other work of this division included the examination of various glandular products subject to the drug sections of the law. A total of 54 products of domestic origin and 1 from an import source were tested. These included 39 estrogenic preparations, 8 corpus luteum, and 8 miscellaneous products. The corpus luteum preparations were investigational samples collected in a preliminary survey. Three labeled as biologically standardized were of satisfactory potency. The remaining five were found to be inert. Further attention is being paid to this class of products. Of the 39 estrogenic preparations, 13 warranted the institution of legal action.

During the year 483 drugs and drug preparations were biologically assayed, as noted in table 4.

TABLE 4.—*Biological assays of imported crude drugs and imported and domestic drug preparations, fiscal year 1937*

Article	Samples examined	Samples requiring detention and exportation	Article	Samples examined	Samples requiring detention and exportation
Imported crude drugs:			Imported drug preparations:		
Aconite	13	0	Digitalis	6	6
Digitalis	21	2	Pituitary	2	2
Ergot	78	1	Epinephrine	1	1
Strophanthus	9	0	Estrogenic	1	0
Total	121	3	Total	10	9

Article	Samples examined	Samples in violation	Article	Samples examined	Samples in violation
Domestic drug preparations:			Domestic drug preparations—Continued.		
Aconite	1	1	Estrogenic	38	12
Digitalis	116	7	Corpus luteum	[1] 8	----------
Epinephrine	73	3	Miscellaneous	[1] 8	----------
Parathyroid extract	7	1			
Posterior pituitary body	80	8			
Squill	11	11	Total	352	43
Strophanthus	10	0			

[1] Investigational.

Inspectors report that many firms formerly manufacturing bio-assay drugs are no longer preparing these extremely potent products. Most of these firms are not equipped with laboratory facilities to insure proper control. The usual reason offered for discontinuance was insufficient volume of business to bear the cost of necessary tests. This indication of a growing consciousness of responsibility to the consumer is one result of the regulatory attention that has been given to this field.

DEVELOPMENT OF NEW ANALYTICAL METHODS FOR FOODS

The simple neutral wedge photometer mentioned in the last report has been improved in several respects. More and better color filters have been added until 10 are now available, a more intense yet uniform lighting system has increased the working range, and a small compensating neutral wedge has made the field more uniform. At present there are at least 14 microcolorimetric methods to which it has been successfully applied.

The experimental photoelectric photometer has been improved and converted into a permanent and practical instrument. Besides affording a sensitive and objective research instrument for comparing existing colorimetric methods or testing new ones, it affords greater flexibility than existing instruments. For example, provision has been made for measurements at low temperatures or at constant temperature, for the measurement of colloidal turbidities, and for the measurement of rates of reaction in those cases where equilibrium is not reached in so short a period as 5 minutes. Thus far it has found use in methods for determining lactic acid, carotene, artificial butter flavor, and adulteration of olive oil with tea-seed oil, as well as in evaluating various colorimetric fluorine methods.

A further study of the principles involved in the isolation of fluorine by distillation was published, this work being an extension of that done last year. The method for the determination of fluorine in spray residues on apples and pears was revised in the light of the experience of the past 2 years and placed in the hands of the fruit industry.

In the field of lead methods the condition is generally satisfactory. Attention has been paid to refinement of the colorimetric dithizone procedure, and a special application to lead in food dyes has been worked out. Simplified procedures for removing troublesome interfering metals, especially tin, bismuth, and iron, have been studied and a method has been devised for their removal before electrolytic determination of lead.

The quantitative determination of small amounts of selenium in food was further studied. The limitations of the turbidimetric, colorimetric, and volumetric procedures were determined and an extremely sensitive electrometric titration was developed.

Work was continued on the determination of minute amounts of mercury, particularly by the use of the photometer. As little as two one-thousandths of a milligram of mercury can now be determined by what might be termed photometric titration.

The guaiac paper qualitative test for hydrocyanic acid was applied in a practical way to testing in transit all shipments of raisins suspected of being contaminated with this highly poisonous fumigant. Investigations of quantitative methods for determining hydrocyanic acid in raisins established the fact that all of the poison is not released by distillation unless the fruit is thoroughly ground.

The recently proposed addition of the yellow vegetable color, carotene, to various macaroni products may make a water noodle look like an egg noodle, or an ordinary flour macaroni like the highly prized semolina macaroni. The detection and determination of added carotene presented an interesting problem because the pigments extractable from flour, macaroni, noodles, and eggs, all consist of the closely similar yellow colors, xanthophyll and carotene, with the former predominating. It was, therefore, necessary to make a clean separation of xanthophyll from carotene. This separation has been accomplished, and applied to a large number of samples of flour, macaroni, noodles, and eggs. Added carotene can now be satisfactorily determined in these products by the new method, which employs the neutral wedge photometer. This development involved a very considerable amount of experimental work on the fundamental classification of the pigments themselves. Photometric measurement of the total carotenoid pigments of flour has proved a much more useful aid in differentiating bleached and unbleached flour than the old, non-

specific, and approximate "gasoline color value." However, the determination of the two pigments separately proved no more useful for this purpose than their determination together.

The use of imitation maple flavor in sirups and other foods purporting to be genuine maple or maple flavored is a serious economic cheat. An almost universal constituent of imitation maple flavors is fenugreek. A method has been perfected for the detection and determination of this constituent.

The colorimetric method for lactic acid in milk has been so modified as to apply to tomato products, and a further modification is applicable to food products in general, including wines.

Intensive studies were conducted on the relationship between alcohol insoluble solids in canned peas and the observed maturity of the identical peas at the time of harvest. These confirmed earlier observations and published work in the conclusion that alcohol-insoluble solids are the most accurate objective measure of field maturity yet developed. In order to make a permanent record correlating different stages of field maturity with the canned product, a large number of very successful color photographs were taken, and use was also made of the services of an expert who has recently developed a remarkable process for preserving vegetable tissue for long periods without alteration in its original color and appearance.

COMMENTS ON COURT CASES

One thousand seven hundred notices of judgment recording the termination of cases in the courts were published during the year. Of these, 1,355 dealt with food cases and 345 with drug cases.

Fines varied from sums as low as $1, $2, and $5 to a maximum actually paid of $1,500. Much higher fines were imposed in several cases but were remitted in large part by the courts. Three jail sentences imposed in connection with second offenses were also suspended and the defendants placed on probation. On pleas of guilty to the adulteration of olive oil with tea-seed oil, two defendants were each fined $6,000 but $5,900 was subsequently remitted in each case.

Courts in general vouchsafed no explanation for the imposition of nominal penalties. In one instance of a $2 penalty for the shipment of filthy and decomposed walnuts the court indicated that it had taken into consideration the fact that the defendant had suffered a $1,400 loss in the seizure and destruction of the shipment by the Government. In another instance dealing with a practically worthless product offered as a treatment for serious diseases of the eye, the court imposed without comment, on the entry of a plea of guilty, a fine of $1 and costs of approximately $35. A creamery in the Central States shipped a consignment of butter containing less than the 80-percent butterfat content required by the statute. The shipment was seized and later released under bond by the court for reworking to eliminate excessive water and bring the fat up to the standard. On the basis of the output of the manufacturer the illicit gain was estimated at $50 or $75 a week and the violation was considered sufficiently flagrant to justify criminal prosecution. In October 1936, a plea of guilty was entered and the court imposed a fine of $1. By contrast, in another jurisdiction a creamery was prosecuted for shipping filthy butter as evidenced by insect fragments and other miscellaneous debris. The defense contended that the filth was not visible to the naked eye and that the Government had to use a microscope to identify it. The court expressed the view that this made the offense all the more reprehensible since the purchaser could not see it himself. He said he was glad the Food and Drug Administration had good microscopes, and imposed a fine of $200.

The same court refused to release a misbranded medicine for relabeling after seizure, remarking that there was too much fraud in the sale of medicines to poor people and that he was disinclined to release the product for this purpose unless there had been a showing of good faith or some other extenuating circumstance.

Other courts have indicated a growing interest in the public protection afforded by the Food and Drugs Act. In passing sentence against a spinach canner who had entered a plea of guilty to the sale of dirty canned spinach a court remarked that if the defendant was unable to manufacture clean food, he had better get out of business and stay out of that court.

While extensive discussion of cases cannot be undertaken in this report, brief references are given to some unusual phases of litigation during the

year. The last annual report referred to a damage suit against administrative officials of the Department who, in carrying out their duty, had reported the arsenic and lead content of an export shipment of apple chops. This suit resulted in disagreement by the jury. It was retried in May 1937 with the same outcome. This litigation grew out of a seizure of apple chops intended for shipment to France. The Government alleged the chops to be dangerous to health because of excessive lead and arsenic spray residues. The court expressed doubt as to the harmfulness of the lead and arsenic present and held that, in any event, the shipment fell within the exemption of the export proviso of the Food and Drugs Act and dismissed the case.

Apple chops is a dried apple product quite extensively used in the manufacture of jellies and apple butter. During the fiscal year 1936 a seizure action involving a domestic shipment of apple chops shipped by the same manufacturer and also containing lead and arsenic spray residues in amounts alleged to be dangerous, was tried in the United States District Court at St. Louis, which handed down a decision against the Government. Testimony for the Government was presented by specialists who emphasized the danger to health from continued consumption of foods containing minute doses of lead and arsenic. Witnesses for the claimant expressed the opinion that the amount of arsenic and lead in these chops involved no public health danger. The decision of the lower court was appealed and the lower court's decision was sustained by the United States Court of Appeals for the Eighth Circuit in an opinion filed April 24, 1937. The opinion said in part:

> * * * It is obvious that the question whether such an amount of arsenate of lead as is present in these apple chops and would be present in the apple butter made from them may make the chops and the resulting butter injurious to health, is, under the evidence, a controversial and doubtful question of fact. * * *
>
> What the Government really seeks is a reversal of the judgment on the ground that the trial court decided an issue of fact contrary to the weight of the evidence. This court has no power to retry the action and to render such judgment as in its opinion should have been rendered by the trial court. The judgment is affirmed.

The full decision will appear in the notice of judgment recording the seizure action. Although this Department recommended that this case be carried to the Supreme Court on a writ of certiorari, the Solicitor General of the United States declined to authorize an application for such writ and the case has been closed.

An extensive series of seizures of olive oil adulterated with tea-seed oil was described in the last annual report which also noted that one of these seizures had already resulted in a court decision favorable to the Government. Trial of another seizure involving another manufacturer, occurred in March 1937. As in the previous case, the new tea-seed oil test developed in the Food and Drug Administration was repeatedly demonstrated by its author in court and its validity confirmed by outstanding State chemists. The claimant introduced expert testimony to throw doubt on the validity of the test. The case was tried by the court without a jury. From the lengthy opinion of the court in dismissing this action, a few statements are quoted. Obviously the entire decision, which will appear as a notice of judgment, should be read. The court stated in part:

> * * * As a legal proposition we have presented to us the duty of making a simple fact finding. Does the olive oil here in question contain an admixture of tea seed oil?
>
> * * * The case however has developed into a scientific controversy. Is what is known to this record as the Fitelson color test, scientifically a convincing test of the presence of tea seed oil in an olive oil mixture? * * *
>
> It may be further interpolated that it seems to be conceded that if the mixture contains a large percentage of tea seed oil—say 50 percent or more—the Fitelson test would disclose its presence. The real controversy is in a case, such as is here averred, in which the percentage of tea seed oil is 25 percent, more or less. * * *
>
> We are not able from the application of the test alone to make a finding of the fact that tea seed oil is present in the seized oil. * * *
>
> We are asked by the libellant to find as a fact that the seized oil is intermixed with at least 20 percent of tea seed oil. * * *
>
> This finding we decline to make because unconvinced of its truth so far that our mind would rest reasonably satisfied with the finding.
>
> We are asked by the intervener to find as a fact that the seized oil was free from any admixture of tea seed oil. This we decline to do for the like reason stated.
>
> * * * So here the question of fact of tea seed oil or no tea seed oil, has become wholly submerged in the other question of the merits of the Fitelson test.
>
> We dispose of it by declining to pass upon it. * * *

Other cases involving adulteration of olive oil with tea-seed oil are now pending in other jurisdictions and presumably will be tried at an early date.

A case of far-reaching importance in its interpretation of the Food and Drugs Act was decided in the United States District Court for the Southern

District of New York in May 1937. It involved the seizure of a consignment of gauze bandages labeled as "Sterilized" and as "scientifically prepared for surgical use under most sanitary manufacturing conditions." Examination revealed living bacteria in some subdivisions of the sample. The manufacturer denied that bandages come within the statutory definition of "drug." In rendering an opinion upholding the Government, the court stated in part:

> The government has proved that these bandages so seized were not "sterilized". That the statement on the cartons that they were so "sterilized" is false. The accepted definition of "sterilization" means that all bacteria are absent in a sterilized bandage. That it is free from all living microorganisms. * * *
>
> The Congress, in the Act now before us, does confine the words "any substance or mixture of substances" etc., to substances "used for the cure, mitigation or prevention of disease." Such only are to be considered under its definition of the word "drug".
>
> Surely the bandages here seized were "substances". As to whether the bandages here seized were to be used "for the cure, mitigation or prevention of disease" we have substantial and uncontradicted evidence in the record from recognized medical authorities, to the effect that they are so used when "sterilized". * * *
>
> The Congress surely intended to exclude from interstate commerce an impure and misbranded bandage pretending to be "sterilized" and "prepared for surgical use", and prevent it from being transported from the manufacturer to people who might reasonably use them. It seems to me that any other interpretation is impossible in the light of the express purpose of the Congress.

In a contested action in the Western District of New York involving a proprietary medicine alleged to be neither a germicide as labeled nor a treatment as claimed for various serious disease conditions, a verdict of guilty was rendered by a jury and a fine of $2,000 imposed, of which $1,000 was suspended. This case is of particular interest in that the court's instructions to the jury supported the Government's contention regarding the implications of the term "Germicide."

The court in the District of Maryland, in imposing penalty upon a defendant who had pleaded guilty to misbranding a mild counterirritant and inhalent as a treatment for pleurisy, spasmodic croup, coughs, congestion, inflammation, pneumonia, etc., made the following remarks:

> You have been selling a patent medicine with representations to the public that it is an effective remedy or a valuable aid in cases of disease when it could not have any possible real value in such disease, and anybody of real intelligence, and particularly a person in your line of business, must have known that. * * * Something more is required of a man who undertakes to make a profit in selling drugs to the public than merely a willingness to change when he is caught or found out by the Department of Agriculture. It is the affirmative duty of the citizen to comply with the law. * * * I do not think any one could well or consistently say it is all right for him to sell this until the Department of Agriculture shut down on him.

FOOD AND DRUG BILL

As in the 3 preceding years, legislative efforts have been continued during the year just past for a more adequate food and drug law. Senate Bill 5, introduced on January 6, 1937, was passed by the Senate on March 9. This bill proposes a comprehensive revision of the present Food and Drugs Act. Other bills of similar character are H. R. 300 and H. R. 5286. H. R. 5854 is designed to amend the Federal Trade Commission Act by authorizing specific control under that act of false advertising of foods, drugs, therapeutic devices, and cosmetics.

At the close of the fiscal year all these measures were pending before the House Committee on Interstate and Foreign Commerce. The principal issues involved in the situation at that time were:

1. Should seizure action to prevent distribution to consumers of a misbranded product be limited, pending court trial of the case, to a single interstate shipment of that article, or should the authority contained in the present law to seize all such shipments be continued?
2. Should seizure cases be tried, as provided by the present law, where the goods are seized, before the courts and juries of the consuming areas where the goods are intended for distribution, or should the law be changed to authorize the case to be removed to the place from which the goods were shipped and there tried before the courts and juries of producing areas?
3. Should the misbranding provision of the present law, which prohibits labeling that is "false or misleading in any particular", be retained, or should the standard of truthfulness thus imposed be changed to ban labels only when "misleading in a material respect"?
4. Should false advertising of foods, drugs, therapeutic devices, and cosmetics be controlled through injunctions and cease-and-desist orders, which

carry no penalty for the initial offense or for subsequent offenses up until the date the injunction or order becomes effective, or should a deterrent to the commission of these offenses be set up by providing penalties for their initial commission?

The significance of these questions is slowly becoming more widely understood. Opinion on the merits of the issues is becoming more definitely crystallized. The fight will be continued until a measure fully adequate to consumer protection has been enacted.

INSECTICIDE ACT

During the year, 2,607 samples of insecticides, fungicides, and disinfectants involving the output of about 700 domestic manufacturers were examined. In addition, 229 samples were collected from consignments offered for importation.

These are classified as follows:

	Samples
Domestic:	
Arsenate of calcium	76
Arsenate of lead (paste and powdered)	130
Paris green	29
Bordeaux mixture and combinations of bordeaux mixture with arsenicals	110
Lime-sulphur solution and sulphur preparations	219
Lubricating-oil-emulsion sprays	87
Miscellaneous insecticide and fungicide preparations for agricultural use	375
Preparations for the treatment of mange of animals	21
Preparations for lice and fleas on animals (including poultry), and for chicken mites	190
Sprays for house flies and for the protection of animals against flies	197
Preparations for the control of clothes moths	258
Preparations for other household insects	329
Disinfectants, germicides, and bactericides	350
Sodium hypochlorite disinfectants and related products	99
Preparations for the control of termites	31
Miscellaneous and fraudulent preparations	106
Total	2,607
Imports	229
Total	2,836

One hundred and two of the domestic samples found in contravention of the law were made the basis of seizure or of criminal prosecution. Ten shipments representing products of 8 manufacturers were seized, and criminal prosecution was recommended against 57 manufacturers.

Fifty-one import shipments found in violation of the act were denied entry or detained pending correction of the label.

AGRICULTURAL INSECTICIDES AND FUNGICIDES

Calcium arsenate, lead arsenate, and paris green, as well as dusts containing them, have received careful surveillance to prevent the marketing of any which might cause injury to plants or which will not do what is claimed for them, thus bringing them within the specific prohibitions of the law. There has been much progress in the development of organic insecticides, such as those containing rotenone, pyrethrum extract, and synthetic compounds, during the past year and many of these preparations are of such a complex nature that field tests are required to determine the truthfulness of their labeling and whether they will cause injury to plants.

Mineral oil has in the past been used extensively as a dormant spray, and in dilute emulsion form on growing vegetation. However, it has been generally considered that oils applied directly to growing vegetation would cause injury. Recently preparations consisting of highly refined mineral oil and pyrethrum extract, similar to the usual household fly sprays, have been put on the market and recommended for spraying directly on growing plants. To determine the limitations of the claims which may truthfully be made for such products it has been necessary to make field tests. These have shown that certain oils properly applied with a sprayer that gives a high degree of atomization may be safely used on a number of garden plants, including string beans which are generally considered to have tender foliage, and that they are effective for the control of a number of the important insect pests such as red spiders, mealybugs, and strawberry leaf rollers.

The principal fungicides for use on plants are those containing copper, such as bordeaux mixture, and those containing sulphur, and for seed and soil

treatment preparations containing copper, formaldehyde, mercury, and zinc. The dry bordeaux mixtures and other copper preparations put out as substitutes for home-made bordeaux mixture have required special attention to make sure both that they will not cause injury to plants and that they will have the efficacy claimed in the labeling. It has been found that the best of the commercial dry bordeaux mixtures may be as effective as a home-made bordeaux mixture when used in a dilution containing the same amount of copper. However, some are less effective and none has been found more effective. Furthermore, some of the dry bordeaux mixtures have been found injurious to foliage, particularly that of apples, on which bordeaux mixture is ordinarily used, and the labeling of such products has been required, where necessary, to bear directions that lime must be added to render them safe to use. Other types of copper fungicides which are frequently marketed to replace bordeaux mixture are now under test. Present indications are that the copper preparations that are safer to foliage than bordeaux mixture are weaker fungicides, and that those which are stronger fungicides are likely to be injurious. In both cases the label claims must be limited to the particular purposes for which the product will be satisfactory.

Increased attention has been given during the past year to tests with products recommended for seed and soil treatment to control damping-off and other seed and soil-borne diseases in seedbeds or propagating benches, in order to determine what claims may properly be made in their labeling. It has been found that the nature of the carrier used in formaldehyde dusts affects the rate at which the formaldehyde is evolved and this results in a difference in effectiveness of the product and in possible injury to the seed or seedling. Furthermore, these tests have shown that some products are limited in their effectiveness to certain organisms causing damping-off but ineffective against others. Control by formaldehyde dusts appears to be particularly questionable against damping-off caused by *Rhizoctonia* and further work on this point is being carried out.

HOUSEHOLD INSECTICIDES

Owing to the improved methods of testing there has been a marked increase in the number of these products examined. A large number of the weaker or ineffective preparations have been removed from the market or the manufacturer has increased their strength. The general standard of such products now on the market is decidedly higher than it was a few years ago.

The labeling of materials sold for mothproofing has required continued attention. Sodium and potassium arsenates and arsenites, sodium fluoride, and sodium and magnesium fluosilicates are the principal inorganic materials recommended for this purpose. These materials are generally applied in solution to woolens by spraying or dipping the goods to be protected. Thorough coverage is necessary as every fiber in order to be protected must have its complement of arsenic or fluorine. Dilutions containing less than one-fourth percent of the active compound cannot be relied on to give protection. Washing in water reduces or removes entirely the mothproofing value of these compounds. Mothproofing agents of an organic nature are applied in oil solution. These are usually removed from the treated articles by dry cleaning and long exposure to sunlight reduces the effectiveness of many of them.

Products sold to protect woolens from moth damage by enticing the moths away from them have been tested and found worthless, and such articles encountered on the market have been removed by seizure action. Further work on paradichlorobenzene and naphthalene packed in perforated containers for use against moths has shown great variation in effectiveness due to the style of packing. The perforations in the containers must be of sufficient number and size so that vaporization of the moth-killing agent is not retarded or they must be recommended for use at a higher dosage than the usually recommended 1 pound per hundred cubic feet of tightly confined space. As a result of this work, many worthless products of this type have been put off the market.

Many of the ant poisons, consisting of a sirup with a poison such as sodium arsenate, sodium arsenite, or thallium sulphate, have been labeled as being effective against all types of ants. Such claims have been found to be unjustified. Certain ants feed on greases and others feed on sweets. A sirup is not attractive to ants of the former type and it has, therefore, been necessary to require that the label claims for ant poisons be limited accordingly.

INSECTICIDES FOR USE ON ANIMALS

Fly sprays for use on horses and cattle are frequently recommended for killing flies as well as for repelling stable and horn flies. A recent survey of such products showed that many of them were deficient in killing power. Steps are being taken in cooperation with the Bureau of Entomology and Plant Quarantine to determine the strength of fly spray necessary to kill the types of flies present in barns and stables and to prevent the marketing of sprays that are too weak.

NEW ANALYTICAL METHODS FOR INSECTICIDES

During the year a number of methods for the analysis of these products have been developed or improved. Among these are (1) an improvement on the method for the quantitative determination of pyrethrin I in fly sprays and certain other pyrethrum preparations, thus making it possible to correlate closely the fly-killing power of pyrethrum sprays with their pyrethrin content; (2) more satisfactory methods for determining rotenone, one of the principal toxic ingredients found in the roots of derris and cube, both in the root powder and in mixtures of these powders with sulphur; (3) an improved method for the determination of fluorine applicable to preparations containing fluorine and aluminum; and (4) methods for the detection and determination of organic thiocyanates, now extensively used in household fly sprays, so that these substances alone and in oils with which they are commonly mixed can be evaluated on the basis of their composition.

CAUSTIC POISON ACT

As a result of 10 years of enforcement of the act, a survey of the trade showed that there is now very general compliance with its labeling requirements. Twenty-three criminal and three seizure actions were instituted during the year. These court actions involved acetic, carbolic, hydrochloric, oxalic, nitric, and sulphuric acids, ammonia, sodium hydroxide, and silver nitrate, or preparations containing these substances, which had been marketed in household-size packages without the warning labels required by the statute.

IMPORT MILK ACT

The trade pact between the United States and Canada stimulated importations of milk and cream during this fiscal year somewhat, but not to the extent anticipated. Department statistics show that slightly more than 102,000 gallons of cream were entered from Canada during the fiscal year 1937. Entries of fluid milk during the same period were negligible. This small volume did not warrant reopening any of the stations on the Canadian border, but representatives of the New York station collected and examined samples from shipments and also made sanitary inspections of the herds and establishments of producers and shippers in Canada.

A dozen permit holders were more or less active in shipping across the border, and since the majority were operators of pasteurizing plants, their combined offerings represented the production of more than 1,000 Canadian dairy farms. The rate of flow across the border was affected by seasonal and economic influences. Periodic inspections revealed that some of the dairymen supplying the larger shippers were lax in their observance of sanitary precautions, and as a result, 21 Canadian farmers were notified that their product would not be acceptable for shipment into the United States until necessary improvements had been effected. The permits of two shippers were suspended temporarily during the year for negligent practices.

TEA ACT

A total of 91,562,794 pounds of tea was examined in the fiscal year 1937. Of this amount, 83,009 pounds were rejected by the tea examiners, representing 0.00091 percent of the total.

Of the tea examined, 18,350,914 pounds was unfermented tea (green tea), 67,169,794 pounds was fully fermented tea (black tea), and 5,910,772 pounds was semifermented tea (oolong tea). Mixed tea accounted for 131,314 pounds.

FILLED MILK ACT

By act of Congress of August 27, 1935, the enforcement of the Filled Milk Act of March 4, 1923, was assigned to the Secretary of Agriculture. This measure prohibits the manufacture or sale within Federal jurisdiction of filled milk, and defines the product as—

> any milk, cream, or skimmed milk, whether or not condensed, evaporated, concentrated, powdered, dried, or desiccated, to which has been added, or which has been blended or compounded with, any fat or oil other than milk fat, so that the resulting product is in imitation or semblance of milk, cream, or skimmed milk, whether or not condensed, evaporated, concentrated, powdered, dried, or desiccated.

A small appropriation was made for the use of the Food and Drug Administration in 1937 for enforcing the statute. Active operations have, however, been practically at a standstill because of the pendency during the entire year of an action under the law against the principal manufacturer of filled milk. An indictment against this manufacturer for violation of the Filled Milk Act was obtained by the Department of Justice in 1935 on the basis of samples collected and analyzed by the Food and Drug Administration. The case has been pending since that time on the defendant's motion to quash the indictment. This motion was argued late in June 1937, and at the termination of the fiscal year the case was still under consideration by the court. This is not the first litigation under the Filled Milk Act which has been instituted by the Federal Government against this manufacturer. A previous action resulted in a verdict by the district court adverse to the Government, based on constitutional grounds. An appeal from this decision was impossible because the initial action had been begun through the filing of an information and not by indictment. The current action based on an indictment of the manufacturer was then initiated by the Government.

Surveys of the market to determine whether other manufacturers are marketing filled milk so far have shown that interstate traffic is almost entirely limited to the defendant whose case is now before the court.

NAVAL STORES ACT

REGULATORY WORK

Eight-four official samples of turpentine and of certain competing thinners, labeled and sold in such a manner as to bring them within the purview of the statute, were collected and examined. Fifty-seven manufacturers were represented thereby. Five citations were issued, and steps to prosecute two manufacturers were taken. One prosecution case was termined with the imposition of a substantial fine.

SERVICE WORK

A total of 1,165 rosin classification and grade certificates was issued, covering 129,688 barrels and drums of rosin, while 23 turpentine classification and gaging certificates were issued, covering 1,785 barrels and drums of turpentine. These inspections were made for 62 producers and shippers.

In addition, 103 samples of turpentine were analyzed on request in the Washington laboratory, and an inspection covering 15 drums of rosin was made at the plant of a consumer. Three turpentine analysis certificates were issued on a portion of the turpentine analyses reported above.

Claims for services rendered under the act for return to the United States Treasury as miscellaneous receipts amounted to a total of $9,316.22

ROSIN STANDARDS

The work involved in the grinding, polishing, and assembling of the glass components into finished rosin standards (also called "types"), which was undertaken for the Administration by the Ordnance Division of the War Department, and carried out at Frankford Arsenal, has been completed. A total of 110 sets of these glass rosin standards has been made up, of which 71 sets have been distributed. These standards are in use by Government naval stores inspectors, State and municipal inspectors, Government research units, firms engaged in the production and distribution of rosin, and also some which buy and consume rosin in their industrial processes.

Sets have been placed on loan in England and the Argentine Republic, where American rosin is an important article of import trade, and in France, where the grading of French rosin is carried out with standards or types based on the official United States standards.

PHYSICAL EXAMINATION OF TURPENTINE AND ROSIN

A public service patent was granted to a member of the Naval Stores Division on a novel photoelectric circuit. Two laboratory photometers embodying this invention are in use, one in the Food and Drug Administration, and one in the Naval Stores Research Division of the Bureau of Chemistry and Soils, for grading rosin and turpentine by means of photoelectric measurements of transmitted light, thereby eliminating uncertainties in personal judgment.

Preliminary experiments have indicated the possibility of detecting the adulteration of turpentine with petroleum or coal-tar oils containing the light aromatic hydrocarbon oils such as toluol, xylol, etc., by means of characteristic absorption bands shown in the absorption spectra obtained with ultraviolet light, using a quartz spectograph.

CERTIFICATION OF COAL-TAR COLORS

One thousand five hundred and forty batches of food colors, representing the output of 31 firms, were analyzed to determine their compliance with the requirements of the Food and Drugs Act. Straight dyes, not including repacked colors, amounted to 511,093 pounds. Forty-four thousand three hundred and eighteen pounds of repacked straight dyes and 373,741 pounds of mixtures were also submitted for certification. During the year 3 batches of straight dyes, 6 of repacked straight dyes, and 16 of mixtures were refused certification after examination. It is noteworthy that the total amount of straight dyes certified was 123,693 pounds greater than has ever been certified in any previous fiscal year. The total number of pounds of repacked material was also the highest in the history of the color-certification work. The total number of pounds of mixtures fell below that of 1925 and 1927, although by far the highest in recent years. The number of firms engaged in color certification is the same as in 1936, but only half that of 1929, when there were 62 certifying firms.

COLLABORATION WITH OTHER GOVERNMENTAL AGENCIES

At the request of the Federal Trade Commission, more than 500 reports were made relating to the therapeutic value of various drugs and devices, and 61 analyses and tests were made, principally of drugs and cosmetics. The products were under consideration by the Federal Trade Commission to determine whether unfair-trade practices were involved in their advertising, labeling, or sale.

In cooperative work with the Post Office Department, medical briefs were prepared in 157 cases and 279 analyses and tests were made of drugs, cosmetics, and devices to determine whether or not their distribution was in violation of the postal-fraud law.

In addition to the above there were examined 2,000 samples of foods, drugs, and insecticides submitted by other establishments of the Government mainly to determine whether or not the products sold to the governmental establishments complied with the purchase specifications. The larger number of samples was submitted by the Veterans' Administration, Treasury Department, War Department, Marine Corps, Department of Justice, Navy Department, and Indian Service.

Other establishments for which analyses were made included the Federal Communications Commission, Interior Department, United States Shipping Board, Panama Railroad Co., Forest Service, Bureau of Agricultural Economics, Public Health Service, Bureau of Prisons, White House, Procurement Division, Agricultural Adjustment Administration, Bureau of Chemistry and Soils, Bureau of Dairy Industry, Bureau of Entomology and Plant Quarantine, Bureau of Home Economics, and Federal Surplus Commodity Corporation.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - - Price 5 cents

REPORT

OF THE CHIEF OF THE

FOREST SERVICE

1937

Report of the Chief of the Forest Service 1937

United States Department of Agriculture,
Forest Service,
Washington, D. C., September 15, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: Few people realize that one-third of our continental land area is forest land and that it is most valuable for forest purposes.

Too few realize that 6 million people get their daily bread from industries dependent on forest resources; that farm wood lots make up more than 17 percent of all farm lands, and help support 2½ million farmers; that forest lands also provide work for millions of people who otherwise might not have been employed; that this work is worth while, noncompetitive with industry; that possibilities for it are well-nigh unlimited.

There is too little realization that forest lands influence farming operations generally; that these lands help protect watersheds, prevent soil erosion, and silting of reservoirs; that they store and regulate domestic and irrigating water.

Recent extensive industrial pulp and paper developments in the South furnish added proof of the many social and economic significances of forest lands. As you know, I am greatly concerned over the South's present situation, and have sounded a warning about the danger of widespread forest exploitation there.

I have felt impelled in this year's report, transmitted herewith, to bring into sharp focus the seriousness and significance of our forest situation, some of the things already done to help meet it, and certain outstanding things still to be done if we are to avoid repetition of social and economic tragedies like those which have been widespread in forest regions generally.

Public ownership and management are established but must be increased. Public responsibility for help in research, and protecting private forest lands from things like fire and disease is clear, and public assistance must be continued. Voluntary action by private owners of forest lands must be encouraged. But these things are not enough. Neither in this country nor in any other have they brought sustained-yield forest management, with security for labor and industry, generally. Instead, public regulation in some form has invariably been necessary. Let's face this fact.

Sincerely,

F. A. Silcox

Chief.

CONTENTS

APPENDIX

Our Forest Lands

1. An economy of scarcity with respect to forests is unsafe. Lumber is but one product of wood, an abundant source of cellulose, lignin, turpentine, drugs, chemicals. It makes paper, rayon, plastics, films, explosives, lacquers, dyestuffs, alcohols, acids, gas for automobiles, food for cattle. It can make artificial wool, adhesives, human food in certain forms. What it may make depends largely on research, invention, development. Synthetic rubber, from by-products of wood, is chemically possible.

2. All forest lands now total 615 million acres—almost one-third the continental United States. Of these—

(*a*) More than 70 percent is privately owned.

(*b*) Less than 30 percent is publicly owned.

3. Forest lands now noncommercial—poor, rough, at present inaccessible—total 120 million acres. Of these—

(*a*) Only four-tenths is privately owned.

(*b*) Six-tenths is publicly owned.

4. Commercial forest lands—capable of growing marketable timber—total 495 million acres. Of these—

(*a*) The best four-fifths is privately owned.

(*b*) Only the poorest one-fifth is publicly owned.

5. Commercial saw timber, originally 5,200 billion feet, is now only 1,668 billion. Of it—

(*a*) The best three-fifths is privately owned.

(*b*) The poorest two-fifths is publicly owned.

6. Of all potential forest growth—

(*a*) Some nine-tenths is on privately owned lands.

(*b*) About one-tenth is on publicly owned lands.

7. Of all forest products—

(*a*) Ninety-eight percent is cut from privately owned lands.

(*b*) Only 2 percent is cut from public lands.

8. Though the difference is not now so great, for 1925 to 1929, inclusive, forest drain exceeded forest growth by—

(*a*) About 2 to 1 in all sizes, but

(*b*) About 5 to 1 in saw-timber sizes.

9. Of forest area needing it, adequate fire protection is still lacking on—

(*a*) Some forty-five percent of all privately owned forest lands.

(*b*) Less than 5 percent of all public forest lands.

10. Even recently, forest fires still burn, each year—

(*a*) Forty-odd million acres in private ownership.

(*b*) Less than one-half million acres in public ownership.

11. Forest industries support 6 million people each year, and wood lots help support 2½ million farmers. Yet—

(*a*) More than 380 million acres privately owned are still without forest management, while

(*b*) Less than 15 million acres—State lands, Federal public domain, etc.—are now without forest management.

12. Private ownership holds the key to our forest situation. With minor exceptions, forest exploitation continues there.

A Three-Point Program

1. **Public ownership and management** have established conservation on the publicly owned national forests. In 38 States, they help protect watersheds and feed livestock and wildlife. They afford recreation to more than 30 million people each year and help support nearly a million. Ratio of private to public ownership is now more than 2 to 1. In general, acreage in public ownership should be the greater.

2. **Public cooperation with private owners.**—State cooperation has been outstanding. Federal appropriations plus Civilian Conservation Corps work already total 82½ million dollars. Public obligations and responsibilities are recognized through coordinated State and Federal action in research and such things as protection from fire, insects, and diseases. This should be continued. With safeguards to insure adequate participation by private owners, it should be extended.

3. **Public regulation**—as a margin of sovereignty over private forest lands—is also essential. It will protect broad, vital public interests. Private owners who recognize social obligations inherent in forest-land management will also be protected, by such regulation, from owners who otherwise might continue ruthless exploitation.

Forest and Human Conservation

Human welfare, a fundamental objective of conservation, depends on wise use of natural resources. We cannot conserve merely by preserving. The good earth offers its soils and its waters. They yield plant and animal life. But we destroy unless replenishment goes hand in hand with use.

Forests are vital tools in the service of mankind. They retard too rapid run-off; help control erosion and floods; conserve soil and moisture. Power from water is the backbone of many industries. More than 2 billion gallons of water are consumed daily by urban centers from Boston to Baltimore. Water from forested slopes is the lifeblood of many cultivated crops. Most of the habitat of our remaining big game is now on forest lands, and much feed for domestic stock. As sources for inspiration, forests foster spiritual and cultural values. Forest recreation totals some 250 million man-days each year.

Exponents of compound interest as a means to huge fortunes say we may have too much timber. Yet in addition to services already mentioned, forests give us building materials and fuel, alcohols, rayons, sugars, naval stores, combs, perfumes, phonograph records, surgical absorbents, newsprint, fiber containers, and thousands of other products in everyday use. Forests occupy more acres than any other crop on American farms; farm woodlands furnish posts, fuel, and supplemental cash incomes to 2½ million farmers annually. And nearly 6 million of our people are directly supported by workers normally employed in lumber, pulp and paper, and other forest industries.

Exploited and mined, forests disappear and communities and families are often left destitute and forlorn. Seven thousand woodsmen once worked out of one prosperous Lake State town. After forests were gone its population dropped to 300. Tar-paper shacks and rusty tin cans have replaced attractive homes and geranium beds in hundreds of communities where forests once seemed inexhaustible. Yet as living resources under planned management those forests could have been renewed and maintained; could have helped stabilize industries and communities and maintain them permanently.

With minor exceptions, our remaining forest lands are most valuable for purposes like those mentioned. They total 615 million acres; about one-third of our continental land area. Noncommercial forest lands are rough and nonagricultural. They occupy 120 million acres, with 48 million in private and 72 million in public ownership. Commercial forest lands total 495 million acres, but under present conditions only about half the timber on them can be logged at a profit. Of this 495 million acres 80 percent is in private, and the poorest 20 percent is in public, ownership.

Forests are instruments for human welfare. The manner in which forest lands are handled is vital to our social and economic structure. Many people think conservation concerns trees alone, but public policy does not. Nor does it consider trees as an end in themselves. Treating

forests as crops it holds that, through use, their true function is to add to man's welfare. Applying this basic principle to all resources of forest lands and to all services they perform, forest conservation helps in many ways to conserve human resources.

PUBLIC FORESTS

With this in mind Congress authorized the national-forest system in 1891. The first Federal units were remnants of public domain, which was in the West. Before long New England and the South needed help. In 1911 the Federal Government was authorized to purchase forest lands. In 1924 the scope of this act was enlarged.

As a State activity forestry in some form began in California, New York, Ohio, and Colorado in 1885. In addition to parks, 36 States now have State forests. Most of them are managed with reference to future timber production as well as for recreation. State forests now total 8,399,456 acres, with about 75 percent in Pennsylvania, Minnesota, and Michigan. As of June 30, 1937, 36 States had met requirements of the Fulmer Act, which authorizes the Federal Government to cooperate in promoting State forests. When funds can be made available, these States are in position to take immediate advantage of that legislation.

Most public forest land is now in national parks, monuments, and national forests. The two former include some 17 million acres, not all of which is forested; are administered by the National Park Service of the Department of the Interior. Park resources are rightfully preserved rather than harvested; inspiration and recreation reign supreme. National forests, administered by the Forest Service, include areas where timber is sold to commercial concerns and—within reasonable limits—is free to local settlers for home use. Watersheds are protected as mature trees are harvested, stands of second-growth improved, young trees planted. There are also national-forest areas where no timber may be cut and where primitive conditions are maintained.

Half the population of Flagstaff, Ariz., depends directly or indirectly on forest products from the Coconino National Forest. Coming as they do from every State, thirty-odd-million vacationists find health and happiness on national forests each year, and spend money locally that in the agrgegate totals a huge sum. In certain Montana counties a 55-million-dollar investment and the livelihood of more than 5,000 people depend largely on planned and regulated use of national forest forage. Ponderosa pine on the Harney Forest in South Dakota is relatively poor, yet through small portable sawmills it contributes 20,000 man-days of work to local families year after year.

These are examples of communities and regions where jobs are steadier, industry and agriculture more secure, the flow of out-bound freight and in-bound merchandise evener because, instead of being exploited, forest-land resources are renewed and maintained through use. In such ways the national-forest system helps bring security to almost a million people who live in and near it. All national-forest resources are administered by a single agency. This has made for coordinated and correlated management; avoided unnecessary expense. It has also eliminated that confusion inevitable if more than one public agency had handled different activities on the same area. As public properties, national forests typify conservation through multiple-use; for more than 30 years they have helped promote human welfare nationally.

PRIVATE FOREST LANDS

National forests now embrace 172,652,201 acres net. In many countries this would be an empire, but private ownership holds the key to the manner in which by far the largest part of our forest lands are handled. It has the best four-fifths of all commercial forest land, almost three-fifths of the saw timber, at least nine-tenths of all potential forest growing capacity. Some 98 percent of our forest products still come from private lands, and drain is heavy there. In important saw-timber sizes it was about five times normal forest growth from 1925 to 1929. Stacked 4 feet high and 4 feet wide the yearly woodpile that goes to make up newsprint alone—and only that which comes from our own forests—would reach from Washington, D. C., almost to San Francisco, Calif. For all timber the drain, enough to surface a highway 80 feet wide from the earth to the moon with 2-inch planks, was about twice all forest growth.

As raw material, forests furnish employment for labor and provide business for industries. Properly managed, forests increase, as money does in a sound bank. If the owner—of money in bank or raw material in forest—uses only this annual interest, or growth, his capital remains unimpaired and brings added security and permanence to him and to labor. Yet under private ownership exploitation is still practiced generally; in many forest-dependent communities jobs, industries, and local agriculture are still insecure.

Forests also help protect soil and conserve and regulate water. About 140 million acres of our remaining forest lands bear on water problems generally. Another 300 million acres exert a major influence on important streams. The Ohio watershed was once 98 percent forested. More than 17,600,000 people live there today. On rough lands unsuited to agriculture, only about one-third of its drainage bears forests now. Under private ownership they have been heavily cut, repeatedly burned, and overgrazed. The Ohio has had many floods in the past. Records show that they are increasing in numbers and height of their crests. The 1937 flood, its worst, affected fine farms and industrial cities in 243 counties in 10 States. More than 640,000 people had to flee for their lives. Financial losses were enormous.

As immediate defenses against floods, people in river valleys must rely on downstream dams and reservoirs and levees built by an efficient corps of Army engineers. Yet the watershed also plays a vital part in any program of flood control. The Ohio drainage is one of many examples of the intimate relationships that exist between soil, water, and forests. Forests there, as elsewhere, render public services that may be greater even than those they have as producers of cellulose, or as property used for private gain.

CONSERVATION'S YOUTH

Conservation—of a sort—is older in the United States than our Constitution. The "broad arrow" marked trees reserved by the Crown to help relieve "the great and pitiful waste" of Britain's native woods. With the tax on tea, it contributed to the Revolution. Yet in 1779 Congress appropriated funds to purchase lands growing timber suitable for naval purposes. Reservations of public-domain timberlands were made in 1820. Forest protection was recognized as a Federal function when in 1822 the

23655—37——2

naval brig *Spark* was ordered to prevent timber thefts along the coast of Florida and Louisiana. In 1828 forest planting was authorized.

These early efforts at forest conservation were ineffective. History records continued thefts of timber "cut to mold at the stump * * * in the form of stem posts, heart hooks, and knees." As the westward trek reached Lake States pine, a reputable Chicago newspaper counseled force to prevent Government agents from interfering with private initiative in public timber, and Federal agents lost their lives under suspicious circumstances.

As iron and steel replaced oak for warships, early forest reservations were canceled. Yet timber looting continued, and laws literally forced public-domain forest lands into private ownership. The intent was to favor the settler; to build up a democracy of small owners. But this was frustrated. The best commercially valuable forest was soon in the hands of a few individuals. Exploitation followed, and when skinned and denuded forest lands could not be sold, millions of acres went back, tax-delinquent, to form a new but well-nigh worthless no man's land.

A FOREST PROGRAM

In certain countries many forest lands have for centuries ranked high as sources for stable employment. Integrated with agriculture, they have been a backlog for a sound and enduring economy. Forests have been logged, but the power of the land to produce has been held inviolate. Annual growth has been harvested, but capital has been maintained. These forests yielded steady profits even during the late depression. Forest as well as political and economic conditions in Europe are of course different from those in the United States. And we don't want to transfer old-world conditions to the new, for we are proud of institutions and practices we have developed. Yet here, as elsewhere, there is a definite public interest that extends to all forest lands, no matter who owns them.

PUBLIC OWNERSHIP

In 1891 Congress authorized public ownership and management as one essential to an adequate forest program for our Nation. This was a departure from the traditional policy of private ownership, but within certain limitations it has demonstrated what forest conservation through planned use can do for people in communities and regions.

As a policy, public ownership and management of forest lands is based on the fundamental principle that Government must step in when, under private ownership, vital common interests are not adequately safeguarded. The many vicissitudes and aftermaths that have on the whole attended private ownership and operation of forest lands in the United States are cause for national concern. Public welfare demands that these conditions be replaced by such stability and continuity as will strengthen rather than weaken the social and economic structure.

To June 30, 1937, the National Forest Reservation Commission has authorized purchase of forest lands aggregating some 15,998,577 acres in 31 States, largely east of the Mississippi River. Some 16,131,460 acres have actually been purchased or are under contract. Twenty-four percent of these purchased lands now bears merchantable timber. Fifty-three percent bears young growth rapidly approaching merchantable sizes. On another 10 percent natural reproduction may, with adequate

protection, be expected to establish itself. On the remaining 13 percent, artificial reforestation will probably be required.

Outside already established national-forest purchase units there are 125 to 150 million acres now so badly depleted or so unattractive to private enterprise that public ownership seems essential to forest restoration and human welfare. Largely in the eastern United States, some 50 million of these acres probably can best be owned and managed by State and local public agencies, the balance by the Federal Government. Another twenty-odd million acres, largely mature timber in or near western national forests, should also be in Federal ownership in the interests of effective, coordinated, and economical administration and to help existing communities now threatened by early timber exhaustion. This program would leave some 270 million acres, largely the best commercial forest lands, in private ownership.

PUBLIC COOPERATION

Congress has set up cooperation—including Federal funds—as a method of helping private owners establish on their lands those forest practices so necessary to the public welfare.

As a second step toward a sound forest program for the Nation, public cooperation with private owners now takes many forms. Research helps eliminate or overcome economic handicaps and lay foundations for productive use of forest and range lands in private, State, and Federal ownership. To help industrial and other owners put their forest lands in better shape, and to help improve conditions in dependent communities, Divisions of State and Private Forestry have been established in the Forest Service. Benefit payments are now available in many States for tree planting and satisfactory timber stand improvement work applied to farm woodlands. More than 2,600 miles of shelterbelts and nearly 6,500 acres of farmstead plantings have been established as a cooperative emergency project. Our forests furnish some three-fifths of the world's naval stores. The Agricultural Adjustment Administration's naval stores conservation program, administered by the Forest Service, encourages conservative chipping, better fire protection, and use of a larger diameter limit for trees bearing one and two operating faces; providing better yields and helping conserve forest-land resources.

In Oregon and Washington 50 Forest Service representatives serve on regional, State, and county boards and help plan for better forest-land use. Unreverted regular and emergency appropriations for Federal acquisition of forest lands total, to June 30, 1937, some 76 million dollars, but regular appropriations for Federal cooperative work with farm and industrial owners of forest lands—plus replacement value of fire prevention and suppression work done on private forest lands under emergency allotments by the C. C. C.—total almost 82½ million dollars.

With public cooperation more forest lands now receive better fire protection, although not so long ago fire on private forest land burned each year an empire greater than all of Maryland, Connecticut, Massachusetts, Rhode Island, New Jersey, and New Hampshire combined. Applying some basic techniques and practices developed and applied on national forests for more than 30 years, more private owners now leave more cut-over forest lands in a more productive condition. And here and there farm woodlands, and occasionally industrial properties, are now managed on a sustained-yield basis. But these are exceptions. On privately owned forest land generally, exploitation still continues.

PUBLIC REGULATION

Forests were once treated as a public menace. It is useless to blame our ancestors, for they had troubles of their own. But our troubles are different, and so are our conditions. We no longer have hostile redskins behind every tree. Population in New York City is now three times what it was in 1770 in the 13 original Colonies. In terms of area, commercial forests have shrunk enormously. Soil, a basic resource, is now carried across half a continent by flood-swollen streams and dust-laden winds. Valleys and once-wooded slopes of the upper Missouri can never again support an aggregation of wildlife that in pioneer days exceeded anything man had ever seen. Remaining forest lands in the Ohio and other great drainages, overcut and overgrazed, can no longer function as they should. Damage from floods and erosion to farms and industrial centers is increasing. As crops, forests can be harvested and renewed, yet on land in private ownership they are in general still exploited.

Public ownership of forest lands is essential to a sound national program of forest and human conservation. So is public cooperation with private owners. The present ratio of private to public ownership is more than 2 to 1. Acreage in public ownership should be greater than in private ownership. With safeguards to insure more adequate participation by farm and industrial owners, public cooperation with them should be continued.

But current conditions raise the question whether public ownership, and public cooperation, are adequate to meet the existing situation. With the many broad interests at stake, and with a crop that matures as slowly as timber does, a margin of sovereignty over private forest lands is also necessary. This sovereignty can successfully be exercised only by government, in which it is lodged.

Post-mortems will not, of themselves, prevent wrecked forest lands, stranded communities, eroded farms, flooded cities. For the national good, positive measures are necessary. Except in individual cases—and they are pitifully few—nowhere in the world has purely voluntary action succeeded in establishing sustained yield forest management, with security for dependent communities. Instead, public regulation of private forest lands has always been necessary. It protects vital public interests. It also protects private owners who recognize social obligations inherent in forest-land management from those who might otherwise continue ruthless exploitation.

Highlights of the Year

National forests—first called forest reserves—were once administered in one Federal department while all work on which administration is based was in another. In 1905 Congress consolidated administration with research and other activities that, since they concerned both national forests and forest lands in private ownership, had always been in the Department of Agriculture.

Since then administration and research have supplemented and correlated each other; single rather than multiple responsibility has brought unity and economy; close association with other bureaus of the Department has facilitated solution of problems having to do with forest insects and diseases, forest watersheds in relation to dependent cultivated crops, farm forestry, use of forest forage by domestic stock and big game, recreation in relation to all other uses, and management of forests themselves—whether on public or private lands—as crops.

In general, these are the responsibilities and the duties of the Forest Service, which approached the fiscal year 1937 with firm belief in its established policy of integrating itself to local communities on a simple, democratic basis that makes for mutual understanding of mutual problems; with a renewed feeling that forest conservation means use with renewal in ways that will bring added security to the Nation.

Distressed regions.—Exploited forests are measured by more than billions of feet of timber gone, millions of acres of wild land tax-delinquent, potential business lost, or ghost towns. These are bad enough, but distressed regions—where values are so low that disheartened and underprivileged populations struggle for a bare existence—are worse. To a large extent rural regions now presenting such social and economic problems are forest regions; conditions within them are due in large part to forest exploitation; human rehabilitation depends in large measure upon forest rehabilitation.

With minor exceptions these distressed regions include 1,300 counties, half our farms, some 58 percent of all farm tenants. Here the average farm is 87 acres, of which 35 are forest land, compared with 222 acres (with 29 acres in forest) in all other counties. Average value of land and buildings is $1,995 per farm, compared with $7,659 in all other counties. Large families are the rule. There are 700 to 1,000 children under 5 years old for every 1,000 women of childbearing age, compared with 600 for most Corn-Belt farming counties, and 280 in some cities. Index of average farm income is under 30, compared with 90 to 120 for typical Corn-Belt counties. Living standards are low, educational facilities meager, undernourishment not uncommon.

To better conditions in these distressed regions, sixty-odd percent of which are forest and wild lands, residents must have part-time work. The potential significance of forest lands, previously exploited, is that in general they are capable of being rebuilt; that although conditions and opportunities for early returns vary from locality to locality, publicly financed, worth-while work on these forest lands can replace a publicly financed dole; that under management these lands can then produce continuous forest crops and afford a more nearly normal standard of living within areas from which much of our future population will come.

Forest communities.—The Federal part of the forest-acquisition program (p. 6) falls largely in these distressed areas, as do some existing national-forest purchase units. One, on the Piedmont Plateau, illustrates the human problems and responsibilities involved. There are 431,000 acres within its boundaries, with 70 percent forest land. Of the 3,000 families on the area, 75 percent are tenants, renters, sharecroppers, or squatters, mostly of long standing. Farms are small, and scattered. The country is rich in forest resources, yet among the homes leaky roofs and earthen floors are common; sanitary facilities the exception rather than the rule. Now only a bare existence is possible.

Land classification reveals small areas that, though now largely second-growth forest, are capable of growing home gardens and perhaps light yields of such crops as cotton. These areas will be used to supplement nonforest land, most of which is now cropped. Forest lands were exploited before Federal purchase began, but rebuilding them will afford opportunities for supplemental cash incomes. With farm and forest lands properly managed, the area should ultimately provide the 3,000 families a reasonably good standard of living.

Under such conditions no attempt to move these people en masse will be made. Instead, and in cooperation with State, county, and other Federal agencies, the Forest Service is attempting simple rehabilitation in place.

In a national forest in the Appalachians, another solution is under way. Here sturdy and independent settlers have for decades lived in a harsh environment. Each family has cleared an acre or two of forest land and cultivated crops, but in a few years the land wears out and is reclaimed again by forest growth. Then the process is repeated. Under industrial ownership most surrounding forest land has been exploited, but on the national forest there remains some virgin timber and enough merchantable second growth to provide, under sustained-yield management, 3 to 4 months' work each year for a limited number of people. And outside the national forest, but within 15 miles of it, is soil which with care can continuously produce worth-while cultivated crops.

With funds and authority from the former Resettlement Administration, and under standards which it approved, the Forest Service bought some of this land, subdivided it into small farms of from 3 to 10 acres each, and has now completed 64 modest but modern home units. National-forest timber is being advertised for sale. The highest bidder will be required to harvest this forest crop so the operation may continue year after year. He will also be expected to employ settlers who are coming—after investigation and approval on the basis of voluntary applications—to their new home units from certain nearby mountain territory. Direct employment of settlers for logging operations in publicly owned timber, with sale of classified products through competitive bids to processors, may be a possible alternative.

Except that it is smaller than average, the family described below is typical of this region. It had a one-room log cabin, built probably 100 years ago, with a few cultivated acres. The father had odd jobs whenever possible. The wife, 38 years old, had been three times to the nearest town, which is only 17 miles away. The two children, 11 and 15, were introduced to ice-cream cones less than a year ago, with an emotional pressure wonderful to behold. The delight of this family in their really cultivable land and their new home is almost unbelievable. Twenty-four hours after moving in, the field had been plowed and corn planted.

Acting for the former Resettlement Administration, the Forest Service has also established a small forest community in the Lake States. It provides opportunities to isolated farm families previously residing in areas which under local rural ordinances are now zoned against farming. New units on this project are 20 acres in size. Occupants will engage in part-time farming, and will be employed part time in forest work on a national forest. As resources are made available, experiences gained and results obtained in these and other forest communities will be applied to distressed regions now or later included in the national-forest system.

Unemployment relief.—For decades the Forest Service has done long-range planning. In managing timber, forage, recreation, and other forest-land resources, it has recorded and kept up to date, comprehensive work programs. When the late world-wide depression struck, and social problems became acute, these programs were expanded and became bases for action which enabled forest lands to help relieve human distress through unemployment relief.

The Civilian Conservation Corps.—Protection for Federal, State, and private forests against fires, pests, and diseases has been an outstanding contribution of the C. C. C., but it has not been the only one. With it have gone development, improvement, and extension. Trained and guided, youth of the Nation have built trails, bridges, lookout towers, firebreaks, telephone lines, cabins, and shelters. They have cleaned out underbrush and old and diseased trees; thinned and improved young forest stands so that they may grow faster; gathered tree seed, established forest nurseries, grown seedlings, and planted them.

Nor have forage and wildlife resources of forest lands been neglected. Reservoirs and drift fences have been built, and areas overgrazed by domestic livestock or big game have been reseeded. To improve fishing in many of the 70,000 miles of streams in national forests, deflectors and dams have been put in, ponds built, millions of small fish planted. To help increase our remaining wildlife, game has been counted and its life histories studied; seed for food sowed and shrubs for coverts planted. And to help save soil and water, simple check dams have been built; trees, shrubs, and grasses established; gullies or sheet erosion retarded or stopped.

Annals of the Army and Navy afford thrilling stories. So do those of the C. C. C. It, too, has been a first line of defense in national and local emergencies. Its record includes service in a Florida hurricane, an Alabama tornado, and a Nevada blizzard; in floods on the Potomac, the Ohio, and the Mississippi; in forest fires in New Jersey, Idaho, and California. It has helped find lost air liners, check infestations of gypsy moth, Dutch elm disease, bark beetles, blister rust, twig blight, and grasshoppers; has helped make nearly 2 million young men healthy through worth-while work during the last 4 years; and has focused public attention on the need for a national program for conservation of America's forest resources.

C. C. C. accomplishments, in statistical form, are available from the office of the Director of the C. C. C. in Washington. For the year ended March 31, 1937, the Forest Service supervised the work of 964 camps, of which 481 were on national forests. Distribution and average yearly number of C. C. C. camps under Forest Service supervision during each of the last 4 years will be found in table 19. The value of job training, always part of educational work within the C. C. C., is attested by the hundreds of thousands of boys who have left the camps for work in the outside world.

The Emergency Conservation Work Act of March 31, 1933, covered a broad field. It helped forest research tremendously; provided for Federal purchase of lands suitable for national forests and wildlife refuges. On June 28 of this year the President approved a bill extending the Civilian Conservation Corps for a 3-year period beginning July 1, 1937.

Other unemployment relief.—Forest work expanded during the depression through Public Works, Civil Works, Transient Relief, and Drought Relief agencies. On all Forest Service projects as high as 80 percent of direct labor was used. As peak needs receded, unemployment relief—other than through the C. C. C.—was continued by allotments from the Works Progress Administration. Its fiscal year 1937 unemployment quotas for Forest Service projects have been exceeded, with worth-while work extended to the equivalent of 20,137 people on a year-long basis. In addition, the equivalent of 2,257 man-years of employment was made available through National Youth Administration projects, and others financed by direct W. P. A. allotments to States. Overhead and equipment were held to a minimum. Costs, held well below sums authorized, permitted savings exceeding a quarter of a million dollars.

Personnel management.—Analysis to develop better methods of obtaining well-qualified and trained individuals who wish to make forestry a career has resulted in (1) closer contacts with forest schools, and more cooperation from them in training and selecting men; (2) more careful selection and placement of students in summer jobs, to give pre-entry training; (3) more intensive use of the probationary period, both as a test of fitness and as a period of planned training under constructive leadership. Personnel management throughout the Forest Service is based on principles of modern employer-employee relations.

Library.—The library, organized early in the history of the Forest Service, is now a leading one in its field. It renders increasingly valuable aid to research, administration, and forestry generally. During the past year current periodicals were scanned and articles indexed in the card catalog and in Forest Current Literature, issued bimonthly to forest schools and forestry agencies at home and abroad. Library catalog cards numbering 46,700 were furnished forest experiment stations, national-forest regional offices, and forest-school libraries; 6,289 books were circulated to individuals; 1,383 consultors came to the library for information; 4,632 pages, printed in foreign languages, were translated.

Audit.—Tabulations in the Appendix show Forest Service expenditures for the fiscal year. Sums involved, and the fact that the organization is a far-flung one, make it essential that there be a practically continuous, independent, thoroughgoing audit. In all subunits in each region, as at experiment stations, the Forest Products Laboratory, and the Washington office, each expenditure is subjected to close scrutiny prior to payment to insure conformity with applicable laws, regulations, and decisions. Field auditors frequently audit and review transactions and accounts—including those affecting property and claims—of the 10 regional foresters, 12 experiment station directors, 1 forest-products laboratory, 146 forest supervisors, and 750 district rangers. Accounting records for appropriations and revenues are maintained under close fiscal supervision. Advice of fiscal experts is constantly available in connection with policies, orders, and instructions which involve fiscal, legal, and procedural problems.

Cooperation.—Primarily a field service, work of the Forest Service is conducted through a decentralized, territorial organization. Broad policy is controlled, and coordination and correlation are secured, by its Washington office, but research is directed through 12 forest experiment stations and the Forest Products Laboratory; all other activities by 10 regional offices. In the fiscal year 1936 regular field personnel, under civil service appointment, exceeded 3,500. Cooperation is a vital factor in all work.

Land planning and recreation.—Cooperation extends to many activities, including organized recreation and land-planning. Constructed, staffed, and maintained by county or municipality, more than 50 national-forest summer camps and playgrounds furnish worthwhile summer vacations to city and valley residents who might not otherwise be able to afford them. Similar arrangements are in force with more than 300 service clubs, religious, charitable, and other organizations. In Oregon and Washington 50 Forest Service representatives serve on regional, State, and county planning boards, planning for better forest-land use. This is in addition to cooperative work with farm and industrial owners of forest lands (p. 7) and cooperation in fire protection (p. 27).

During the winter of 1936 representatives of the Forest Service met with the subcommittee on recreation of the interdepartmental committee on health and welfare activities, of which Eduard C. Lindeman was chairman. Outlining its recommendations for coordinating recreational activities of various Federal Departments, this committee analyzed

major reasons for the growth of leisure-time activities during recent years, and definitely recognized recreation as something that has developed naturally and in connection with other primary national-forest uses. It pointed out that recreation must be promoted by many agencies, including bureaus of the Departments of the Interior, Agriculture, and Labor, and emergency agencies such as the National Youth Administration, the C. C. C., and the W. P. A., else it would be unnecessarily restricted and ineffective. Suggesting the need for a focal point through which Federal policies might be correlated, the committee also expressed the belief that the fundamental principle of territorial integrity must govern in actual administration of recreational activities by land-management agencies.

Forage.—Grass and browse occur in the national forests in combination with timber, and on higher portions of many major watersheds. More than 83 million acres of national forests are used, each year, by some 1⅓ million cattle and horses and nearly 5⅔ million sheep. Field work on the project of reexamining allocation of national-forest grazing privileges is now practically completed. The approach has been mainly through an analysis of economic elements surrounding range and cultivated-crop conditions in selected representative areas. In the analysis and the general application of results, the effort will be to correlate national forest range privileges with long time social and economic needs of each community. (See Distribution Survey, p. 20.) No major changes in administrative policy will be made until proposals have first been presented to interested agencies, including cooperative neighborhood livestock associations. The latter now total 763 in territory tributary to national forests in the West.

At the request of the A. A. A., and largely financed by it, the Forest Service also acted during most of the fiscal year in a technical and advisory capacity in the range conservation program. In the West it assigned experienced men to supervise the job of determining private land range capacities and acceptable grazing practices. It also examined some 56 million acres of range, and suggested and helped develop a manual of Technical Instructions for Range Surveys which is adopted as standard by the former Resettlement Administration and the Soil Conservation Service of the Department of Agriculture, and the Indian Office and the Grazing Division of the Department of the Interior.

Naval stores.—In 1936 and 1937 the A. A. A. financed but delegated to the Forest Service administration of the naval stores conservation program. Field administration is by the regional forester at Atlanta, Ga. Experienced inspectors and checkers work out of Savannah, Ga., and Jacksonville and Pensacola, Fla. Cooperation is maintained through district advisory committees of the American Turpentine Farmers Association. The program encourages such practices as conservative chipping, better fire protection, and use of a larger diameter limit for trees bearing one and two operating faces; helps provide better yields and conserve forest-land resources. Delegation of authority by the A. A. A. avoids duplication of an existing organization and simplifies relations between farmer and the Government.

Wood-lot management and marketing.—Effective and practicable methods for organizing and operating farm wood lots on a cooperative basis are being worked out on a project near Cooperstown, N. Y. The object is to assure owners the benefits of collective action in managing their wood-lot holdings and in harvesting, processing, and marketing their forest crops. Originally the Otsego Forest Products Association, this project constitutes a case study of cooperative management in rehabilitating farm forests and providing revenues to 232 member farm-woodland owners. A loan of $99,000 was obtained from the former Resettlement Administration to provide working capital and finance construction of a processing plant.

Reforestation.—Typical of cooperation by representative organizations is that by the General Federation of Womens' Clubs in 1936 and again in 1937. Renewing and stimulating interest in administration and use of the national-forest system generally, this carefully prepared plan—conceived by the chairman of the conservation division of the federation—also resulted in club reforestation projects throughout the United States.

Planting sites were selected by clubwomen, who financed the work done there by experienced Forest Service personnel. Gavels made by the C. C. C. from woods characteristic of local regions were presented to individual clubs as awards of merit. A special gavel was used by the president of the federation during its 1937 council meeting at Tulsa, Okla. The largest State project was conducted by Illinois clubs.

Education.—During the calendar year 1936, public interest in forest conservation found expression in 51,000 inquiries received by the Washington office alone. This was an increase of 20,000 over the preceding year. Particularly noticeable were educational activities of clubs and societies, and a well-defined demand for instruction in conservation in schools and colleges. Assistance was rendered, throughout the year, in assembling accurate and up-to-date material about conservation through use of renewable resources.

A Nation-wide forest-fire-prevention campaign, launched early in 1937, centered about a painting created and donated by James Montgomery Flagg. Accepted by the President, it is now reproduced in poster form. Production and Nation-wide distribution were made possible in large part by cooperation with various national and other associations and organizations.

In cooperation with the Department and the National Broadcasting Co., the Forest Service continued preparing material for that portion of the Farm and Home Hour program entitled "Uncle Sam's Forest Rangers."

Flood control.—The Omnibus Flood Control Act of June 22, 1936, established a new Federal policy in flood control. Under it the War Department remains the national agency for downstream engineering, including levees, dams, and other engineering works, but the Department of Agriculture is now recognized as the agency to undertake investigations and measures for run-off and water-flow retardation and soil-erosion prevention on watersheds.

This work must be cooperative. The Secretary of Agriculture has therefore created a flood control policy committee. It includes chiefs of the Bureau of Agricultural Economics, the Soil Conservation Service, and the Forest Service. The Director of Information for the Department is its chairman. Correlation is provided by a flood control coordinating committee with members from the three Bureaus concerned, and liaison representatives from others. During the past year this correlating committee has developed an integrated program of work within the Department, and effective cooperation with the War Department.

With the Omnibus Flood Control Act, and the fact that nearly one-third of our continental land area is forest land, work previously handled as a part of forest-management research and of range research now calls for greater attention. Accordingly, a *Division of Forest Influences* was set up during the year.

At the crossroads.—The deep South [1] is ordinarily thought of as a land of corn, sugarcane, and cotton, yet the forest survey shows at least 60 percent of it still in forest growth. If its power to produce successive forest crops is restored, this forest land—95 percent of which is in private ownership—will be one of the region's soundest bases for prosperity. Recently planned investments by pulp and paper interests about double this industry's demands on southern forests that have for decades been exploited for lumber, naval stores, and other forest products going to national and world markets. In organized groups, southern pulp interests have endorsed woods-practice rules which, however, are inadequate to assure sustained-yield operations.

Pulp representatives have bought timber rights from many farmers. Certain of these rights cover forest lands said to bear 10 to 20 cords per acre, with some stands growing at the rate of a cord per acre per year. Assuming a purchase price of only $3 an acre, with a long term of years in which to operate, and contracts that call for cutting all timber—without leaving a basis for future crops—the stage is set on such lands for reexploitation. And if such a practice continues, the land, the farmer, and the whole social and economic set-up must inevitably suffer.

The South stands now at the crossroads.

[1] Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Oklahoma, South Carolina, and Texas.

23655—37——3

National-Forest Administration

Mention of the national-forest system will be found on pages 4 and 9; expenditures for national-forest protection, improvement, reforestation, and extension, and receipts, are tabulated in the Appendix.

National-forest properties.—Gross area of national forests as of June 30, 1937, was 211,521,166 acres. The net was 171,403,306 acres, with 1,248,895 acres in course of purchase. Purchase units not yet established as national forests included 1,312,798 acres actually acquired to June 30, 1937, under the Weeks law, and 440,398 acres in process of acquisition. Current additions to and eliminations from national forests are shown in table 1. They resulted in an increase of 14,086,649 acres in gross area. Eliminations were minor except for the Wichita National Forest, transferred to the Bureau of Biological Survey. The Santa Barbara Forest, Calif., was renamed Los Padres. Certain areas were transferred from one unit to another to simplify protection and administration and reduce costs. Record of purchase units given national-forest status during the year will be found on page 15.

LAND ACQUISITION

There are several major problems for which acquisition and management of forest lands by State or Federal agencies appear to be the most effective, perhaps the best practicable, solution.

One has to do with land utilization. Extensive surveys show 150 to 200 million acres once bearing virgin forests but now badly depleted or otherwise unattractive to private enterprise. Originally exploited, these lands have been repeatedly culled for such things as fence posts and cordwood. Fires have been numerous and unchecked; sheet and gully erosion are common; tax delinquency is prevalent. Already a no man's land, these areas are becoming an eyesore and a public menace. Yet on the whole they are still valuable for forest purposes. Taken in time, protected and properly managed, forest growth can be restored on them. Instead of an ever-present menace, with resources renewed these lands can contribute to local and national security.

A pressing human problem is another with which public acquisition of forest lands has to do. As indicated on page 9, distressed regions—which include half of all farms, 58 percent of all farm tenancy, people with small incomes and big families—are to a large extent coincident with exploited forest lands. Yet worth-while work on these lands, publicly financed, can replace a publicly financed dole, rehabilitate a disheartened and underprivileged population as well as the land and its resources.

Public acquisition and management of forest lands also has its place in the national job of watershed protection; in providing food and shelter for our remaining wildlife and health and happiness to millions of vacationists; in making opportunities for industry and labor; in bringing social and economic security to families and communities. Indeed, if private owners of forest lands do not redeem their public responsibilities, State and Federal acquisition—on a scale greater perhaps than that suggested on page 7 seems the only practicable way adequately to protect the broad public interests at stake.

Acquisition through exchange.—Private lands best suited to public ownership, now within national forests, are gradually being acquired by exchange under the act of March 20, 1922 (42 Stat. 465) as amended, and that of March 3, 1925 (43 Stat. 1215). Medium of exchange is national-forest land or stumpage. Among exchanges approved during the fiscal year by the National Forest Reservation Commission were seven with Michigan. They involved 85,294.33 acres of offered lands, valued at $243,621.66, and 73,834.34 acres of land selected by the State, valued at $243,616.99. As a result of these and similar transactions both State and national forests will be consolidated, and costs of administration and protection reduced.

Eighty-eight specific private-land exchanges conveyed to the United States, during the year, 150,036 acres valued at $494,243. There was granted in lieu 31,449 acres, valued at $55,145 and 119,694,000 board feet of national-forest stumpage with a total appraised value of $283,776. Net gain in national-forest area was 118,587 acres. In addition the Secretary of Agriculture approved and referred to the Secretary of the Interior for further action 117 cases involving 222,230 acres of private lands valued at $1,355,080; 84,026 acres of national-forest land valued at $310,578; and national-forest stumpage valued at $903,300.

Exclusive of those with certain States, 1,284 exchanges vested in Federal ownership 1,999,455 acres valued at $7,159,205. This is to and including June 30, 1937. In lieu, the Government granted 510,667 acres valued at $2,107,415, and 1,517,686,000 board feet of national-forest stumpage valued at $3,970,069. Net result enlarges the national forests by 1,488,788 acres, increases the volume of national-forest stumpage eventually available for economic uses, and simplifies and reduces costs of national-forest protection and management.

Acquisition through purchase.—As of June 30, 1937, 35 States and Puerto Rico have granted consent to Federal purchases of forest lands for national forests, either throughout the States or in parts thereof. Several purchases involve areas which contain stands of merchantable timber. Placed on a sustained-yield basis, rather than being hastily liquidated, these areas will ultimately help stabilize local communities and industries.

Purchase of 6,595 acres in the Mary's Peak unit, Oregon, will help protect domestic water supplies for Philomath and Corvallis. Purchase of 15,420 acres in Provo and Davis Counties, Utah, will make it possible to carry forward a soil-erosion program now well under way. The year also marked initial purchase of lands in the Arrow Rock unit of the Boise National Forest, Idaho, originally established to help protect the Arrow Rock Reservoir, now seriously silted by erosion.

No new purchase units were established during the year. Additions to established purchase units included the Armuchee and Lookout areas to the Chattahoochee, and others to the Sumter, Huron, and Hiawatha.

During the fiscal year the Angelina, Conecuh, Chippewa, Croatan, Cumberland, Davy Crockett, Hiawatha, Sabine, and Sam Houston purchase units were proclaimed national forests, under names given; the Wambaw under the name Francis Marion. The Long Cane, Enoree, and the South Carolina part of the Nantahala were consolidated as the Sumter National Forest. The Mesaba purchase unit was added to the Superior National Forest, the Okmulgee and Talladega units were designated as the Talladega National Forest, the Unaka unit was added in part to the Pisgah and in part to the Cherokee National Forest.

At two meetings during the year the National Forest Reservation Commission approved for purchase 425,637 acres at an aggregate purchase price of $2,124,736. Area vested in Federal ownership by final payment and recording of deeds during the year aggregated 3,450,202 acres. In addition to lands acquired by purchase, the Federal Government holds within the same areas 2,531,929 acres acquired by donation and reserved from the public domain, and 276,538 acres acquired by exchange. Its complete holdings within purchase units aggregate 17,048,088 acres. In addition 1,758,956 acres are in course of purchase. Details are given in annual reports of the National Forest Reservation Commission.

At the close of the year there had been approved and established under the Weeks law a total of 81 purchase units in 31 States and Puerto Rico, and all acquisition funds carried in the 1937 regular appropriation bill, $2,500,000, were obligated. No allotments for the purchase of forest lands were made from emergency funds during the fiscal year.

Acquisition through donation.—The Secretary of Agriculture is authorized, under the acts of June 7, 1924 (43 Stat. 653) and March 3, 1925 (43 Stat. 1133) to accept donations of land for national-forest purposes. During the year 28 tracts, embracing 38,644 acres, were donated. Total donated to June 30, 1937, is now 279,573 acres. In general this is land cut over years ago, but now bearing second-growth stands. Donations of small areas for administrative purposes were also made.

Abstracting.—On January 8, 1937, the Secretary of Agriculture approved transfer from the Solicitor's Office to the Forest Service of the responsibility for abstracting land title records, getting "curative material", and procuring and recording a sufficient deed to the United States in acquisition cases. The 190 persons transferred or detailed from the Office of the Solicitor to the Forest Service to carry on this work are now part of the Forest Service organization.

NORTHERN PACIFIC LAND GRANT

Hearing in the suit to adjudicate the equities of the Northern Pacific R. R. Co. under the land grant of July 16, 1864, and resolution of May 31, 1870, was held before a special master at Spokane, Wash. After he submits his report to the court, the Government and the company will be allowed to file exceptions, provided they so desire. Under the act of May 22, 1936, either party to this suit has the right of appeal to the Supreme Court of the United States for final decision relative to points of law. Prospects of final decision at an early date seem remote.

RESETTLEMENT LANDS

The former Resettlement Administration had planned eventually to turn certain of its acquired lands over to the Forest Service for administration as parts of national forests. Informal agreement was reached, legal and procedural questions are now being worked out, and transfer may be expected of lands which can most effectively and economically be administered as parts of the national-forest system.

BOUNDARY ADJUSTMENTS

Need still exists to protect and administer some 12 to 14 million acres of public-domain timberland and woodland outside the national-forest system, and to make certain other national-forest boundary adjustments. One of the most critical problems is where certain narrow strips of foothill lands lie between national forests and cultivated valley lands. In many such cases valley stockmen depend upon foothill lands, administered by one Federal agency, for spring and fall range; upon nearby national-forest lands, administered by another agency, for summer range. To secure effective and economical administration, and to prevent confusion, both foothill and mountain lands should in such cases be under one administrative agency.

During the fiscal year 32 bills were introduced in Congress covering 22 individual cases of this type, but none received approval by both Houses of Congress. Clearance was obtained in the executive branch of the Government, however, for addition of one such strip to the Uinta National Forest, Utah, and another to the Harney National Forest, S. Dak. In both these States additions can be made by Presidential action.

CLAIMS, SETTLEMENT, SPECIAL USES

Final application for patents for lands within national forests totaled 93 for homesteads, 74 for mineral lands, during the year. On the former, 71 favorable reports were made by the Forest Service and 22 unfavorable; on the latter, 57 favorable reports were made and 17 unfavorable.

There are practically no national-forest lands now suitable for entry as homesteads. Recommendation is renewed that mineral land laws, insofar as they apply to national forests, be modified so claimants may obtain title to the ore body only, with right to use as much of the surface as is necessary to carry on mining operations. In no way interferring with bona-fide mining, such an amendment would prevent use of mineral land laws for acquiring title to national-forest lands for nonmining purposes.

Uses of small areas of national-forest lands under special use permits show a steady increase. Number of such live permits at the end of the fiscal year was 40,722. This is 1,355 more than were in force at the beginning of the year. Rental charge was made on 22,112 of these permits. The remainder were issued without charge. Special-use receipts for the fiscal year totaled $340,492.93.

SURVEYS, MAPS, PHOTOGRAPHY

All Forest Service surveying and mapping conforms to standards established by the Federal Board of Surveys and Maps. Map and survey data of other Federal agencies are used when they are available and can be supplied within a reasonable time. Maps for administrative use have been published on various scales for most national forests and purchase units. Recreational folder maps and special maps are also published, and relief models have been prepared for many western forests.

Aerial photography during the year covered 11,500 square miles. Surveying by ground methods covered 1,280 square miles. At Forest Service photographic laboratories in Washington, in addition to the regular work, photographic requisitions are filled for 12 other Government bureaus.

PROTECTION FROM FIRE

During the first 5 fire seasons after national forests were transferred to the Department of Agriculture, weather conditions were relatively favorable, as they had been since about 1889. In 1910 fire danger unexpectedly assumed explosive characteristics. Since then there has been 1 comparable bad weather year during each of the half decades from 1915 to 1924, inclusive, and 2 bad years in each of the half decades from 1925 to 1934, inclusive. As is indicated by the fact that 58.7 percent of the national-forest area lost from 1910 to 1924 was burned in 7 bad years, this increase in frequency of extreme years is one fairly reliable index to the unfavorable trend of fire weather to date.

Forest-fire control as a science began as a result of the 1910 season, when nearly 5 million national-forest acres were burned over and damage to tangible values exceeded $24,000,000. Since this disaster the weather has taken on increasingly unfavorable characteristics, and human use has increased enormously, but the technology of fire control has advanced to a stage which now entitles it to a place among modern developments in science and industry.

In perspective, accomplishments since 1910 in forest-fire control on national forests are indicated by a well-sustained downward trend of area lost. Average number of acres burned per 1,000 acres protected has dropped from 7.2 in 1910–14 to 2.1 in 1931–34, with an average reduction during each half decade of 27 percent from the average for the previous half decade. National-forest average for 1935–36 is only 1.6 acres burned per 1,000 acres

protected. The record for 1937 may approach that for 1930 and 1933, when losses were held to eight-tenths of an acre per thousand. The record for 1935 and 1936 is given in table 7.

To maintain the previous rate of 27 percent reduction in average loss for each half decade will become more difficult as losses are brought closer and closer to the irreducible minimum. To balance this influence of the law of diminishing returns, new measures to guard against surprise fires, and to strengthen the complicated structure of forest-fire control, are being employed. Among them are:

Rechecking and replanning.—The general purpose is to discover and correct weak spots before they are disclosed by disastrous fires. Relative fire danger under varying conditions is being carefully reanalyzed, and the latest techniques employed to determine whether fire lookout stations, road and trail systems, and other facilities have been so planned as to guard most effectively against runaway fires.

Fire-weather forecasts.—Progress has been made by the Weather Bureau, Department of Agriculture, in forecasting fire-weather conditions. Specialists have been equipped with mobile units for ascertaining and interpreting weather conditions in particular localities. Fire-control executives are beginning to receive the forecasts they must have to handle their work intelligently. It is hoped this development will continue until reliable fire-weather service is supplied as needed.

Fire-control techniques.—There are now available, as a result of research and experimentation, certain techniques which make it possible to provide fire-danger meters. These instruments are in use in two national-forest regions, permitting day-by-day determination and integration of moisture content of forest fuels, humidity, wind velocity, and other fire-danger elements. This gives flexibility in management of man power in relation to actual day-by-day fire danger. Research expects to provide a danger meter which will make such flexibility possible for every national-forest region.

Technology of forest-fire control has produced many items of specialized equipment, now described in a new fire-control equipment handbook. To promote standardization and facilitate purchasing, complete specifications have (where appropriate) been included. They are available to executives, manufacturers, and others interested.

Training.—Most forest fires are discovered and handled in their early stages by guards working alone or in charge of small groups. Results, in these critical stages, may largely be measured by the judgment and competence the individual fire guard puts into his work. Training, always essential under such circumstances, is doubly so because fire guards are employed each year for a period of about 3 months only, and they naturally seek better and more permanent jobs. This necessitates making protection activities click with a guard force ordinarily made up of from 25 to 50 percent of green men each year. To help meet this situation spring training camps are provided, as are frequent inspections on the job. To supplement and complement these measures, a fire-suppression handbook has been distributed. After revision, it will be made available outside as well as within the Forest Service.

Chemicals.—Under direction of a chemical engineer of experience in its application to municipal fires, a systematic effort is being made to utilize fire foam in fighting forest fires. Besides a tank, this requires a new type of double hand pump, carried on men's backs and operated by individual fire fighters. Already developed and tested, the tank is a two-chamber affair containing two solutions of foam-producing chemicals. When the foam solutions—which it is hoped may be several times as effective as equal weights of water—are not available, water can be used. Engineering and chemical problems involved in the use of foam solutions from forest fire-fighting tank trucks have also been solved during the year, and one test tank truck has been produced.

Aircraft.—Because of distances involved, and time required for ground transportation, forest-fire control has turned to aircraft for rapid transport. During the year new methods have been developed for the dropping of supplies and equipment from moving aircraft. They are simple, can be applied by inexperienced men, and use materials available at any small town. This makes possible high-speed transport of materials to exact spots needed in fire-fighting operations; spots often unreachable within time limits necessary to successful fire control by ground transportation. Experiments have also been carried on in dropping chemicals from the air directly onto going forest fires. If the autogiro type of aircraft is developed to larger pay-load capacities, many obstacles in the way of treating fires from the air will be removed.

PROTECTION FROM TREE DISEASES AND INSECTS

Continued improvement in conditions in 1936 reduced the need for control of forest insects on national forests. It was again possible to devote a large portion of insect-control funds to extensive surveys permitting discovery of incipient infestations before they reached epidemic proportions. This was good insurance.

Bark beetles.—Oregon and Washington have experienced heavy timber losses from bark beetles. For the period 1931–35 those losses totaled 4,500 million feet board measure;

only 100 million feet less than the total lumber cut for that period. Now the condition is improved there. Losses on forest land in all ownerships have fallen from 1,707 million board feet in 1932 to an estimated 400 million board feet in 1936.

Total number of trees treated for bark beetles during the year on all national forests was 66,631. The situation is still threatening on some areas.

Tent caterpillars.—The tent caterpillar has badly defoliated white birch and aspen stands in the Lake States. Most serious epidemics have occurred on the Superior and Chippewa National Forests, used extensively for recreation, in Minnesota. Caterpillars so polluted the waters, and were so obnoxious generally, that recreationists appealed to the Forest Service to start control. This was done, on restricted areas having high recreational use, by spraying trees with an arsenical poison. Results proved effective locally. A total of 520 acres were treated, in 65 different locations. Private owners and civic organizations cooperated financially.

A single infestation of this insect seldom kills a large portion of the stand, but repeated infestations will. They also weaken the trees and leave them subject to attack from other insects and fungus diseases. This infestation covered so big an area that with funds available broad control was impracticable.

White-pine blister rust.—Blister rust has now spread to all important white pine regions in the United States and Canada. The major control problem is now in valuable white pine types of the West, where 2,500,000 acres of national-forest lands still need protection. During 1936, 140,000 acres of western white pine in northern Idaho, eastern Washington, and western Montana, and 74,800 acres of sugar pine in southern Oregon and northern California, were placed under protection. In the former area, with some 1,392,000 acres still to be cleaned of *Ribes*, 885,000 acres have been covered to date. Spread of the disease during the last year has been very rapid. Unless control efforts are greatly increased, large areas of valuable young white pine will be killed. Even at the increased 1936 rate, at least 4 more years will be required to complete initial control. To be properly effective, control should be completed within the next 2 years.

Choice sugar pine stands in Oregon and California now segregated for protection aggregate 1,108,000 acres. Largely because efforts have been centered in western white pine, control in sugar pine has not yet progressed very far. If this pine is to continue as an important commercial species, prompt protection must be provided.

In the northeastern United States the advance of blister rust has been fully arrested by control. This shows what can be accomplished in the West if adequate steps are taken promptly. In Georgia, North Carolina, Virginia, West Virginia, and Tennessee, some 139,000 acres in national forests were protected against blister rust during the year. In the Lake States, where extensive stands of northern white pine are found, 89,821 acres in national forests were protected.

TIMBER MANAGEMENT

Market conditions and sales.—Improvement in demand for lumber continued through 1937. Prices rose, production increased, markets remained firm. National-forest timber sales showed increased cutting activity and caused some financial difficulty in providing personnel necessary to give proper administration.

Demand for new sales of national-forest stumpage increased sharply. Use of trucks and tractors stimulated selective logging. This made it possible to sell small, isolated tracts of timber not previously marketable. As protection to a stand of virgin fir, and as a salvage operation, one sale on the Olympic National Forest covered dead and down timber only. The operation was a success. The purchaser wanted more.

National-forest timber cut under sales and land exchanges during the fiscal year totaled 1,290,610,000 board feet, an increase of more than 26 percent over 1936. Receipts totaled $2,849,382, an increase of $687,711. No large sales were made to supply new milling capacity.

All classes of sales increased during the fiscal year 1937. Transactions covering miscellaneous products such as turpentine, shrubs, burls, Christmas trees, tanbark, and bow staves, totaled 1,214. Timber sales under $500 in value totaled 18,863. This was an increase of 652 over 1936. Those having a value of over $500 totaled 263, 85 more than in the previous year. Total for all three classes of transactions was 20,340. Demand for fuel, fencing, and building material increased during the late depression; did not fall with return to prosperity. Instead, the increase continued. Utilization of dead and down timber, and material for thinnings, is encouraged. National-forest timber sale business for the fiscal year is summarized in tables 8 and 9.

Sustained-yield and national-forest stumpage.—Despite the end of virgin timber supplies now in sight in many localities, there are situations where by practicing selective logging, by purchasing additional timber, and by willingness to reduce production, it is possible for operators of private stumpage to switch from a quick liquidation basis to one of sustained operations, and bring security to families and communities dependent on forest

resources. Wherever adjacent to such holdings, the policy is to sell national-forest timber at such times as will help convert private operations to a sustained-yield basis. The controlling policy in the sale of national-forest timber is sustained yield, and the Forest Service refuses to sell stumpage when to do so results in quick liquidation.

Stand-improvement work.—This year, as last, overcrowded and defective stands of young timber have been put in condition for good growth by thinnings and improvement cuttings, largely by the C. C. C. One instance is on the Harney and Black Hills National Forests, S. Dak. Here more than 200,000 acres of crowded and stagnated young ponderosa pine have been thinned. In the Lake States effective work has been done in spruce, red pine, and jack pine. In eastern hardwoods a large portion of the worth-while cultural work on national forests has already been accomplished, and most unworked areas now contain merchantable products which should be sold before cultural treatment is given.

Planting.—Area reforested on national forests during the year exceeded that of any previous year by 82,351 acres. Trees were planted on 214,306 acres. Tree seeds were sown on 8,769 acres. Total area reforested was 223,075 acres. Production of stock has required unusually careful planning, and development of extensive nurseries.

National forests include 4 million acres of land now nonproductive but suitable for growing forest trees. Even though reforestation was greater than ever before, accomplishments in the calendar year 1936 made little headway toward completing a job of this size. Under the Knutson-Vandenberg Act, appropriations for planting are limited to $400,000 in any 1 year. The C. C. C., and allotments from emergency relief appropriations, made this year's program possible, but current curtailment in relief appropriations presents a real problem. Unless legislation permits larger regular appropriations it will not be possible to maintain present progress. Since it requires from 3 to 4 years to produce proper growing stock, it will be well-nigh impossible to plan in advance unless appropriations for reforestation are made permanent.

Greatest planting needs are in the Lake States and the South. Here national forests have for the most part been built up by purchases of private lands heavily cut and burned before being acquired. Much of this land, particularly in the Lake States, offers difficult planting sites, but once trees are established, the soil produces good forest stands. Generally accessible, and relatively near heavy centers of population and demand, these areas are particularly important as wood-producing centers. Yet with original forests overcut and ruthlessly exploited, lumber and other forest products must now be brought here from long distances. Freight alone costs more than the cost of the finished product not so long ago. Lumber prices are high. With forests reestablished, growing, harvesting, and manufacturing done locally, and freight rates reduced to a short-haul basis, homes and industries should be stabilized; the present picture should change for the better. Nearly 90 percent of all calendar-year planting was in the Lake States and the South.

Total national-forest area planted and sown during the calendar year 1936 is shown, by States, in table 10. Table 11 shows present approved annual output of national-forest nurseries. It has been reduced, for some larger nurseries, to permit practices made necessary by drought and other special conditions. Designed primarily to produce stock for national forests, small amounts of coniferous stock from these nurseries will again be used in State cooperative work under the Clarke-McNary law.

THE RANGE

Weather and forage conditions.—Broad and local cycles of drought in the past decade or more have emphasized the need for conservative use of forage as a factor in minimizing or avoiding economic adversities and insuring security to dependent livestock operations and communities.

In Montana and northern Idaho (region 1) drought conditions of 1935 continued. This further reduced volume and vitality of forage already affected by moisture deficiencies of nearly a decade. The Bitterroot and the Beaverhead Forests were two bright spots, but eastern Montana was again ravaged by severe Mormon cricket and grasshopper infestations.

In Colorado, western Nebraska, southwestern South Dakota, and that part of Wyoming east of the Continental Divide, more favorable moisture conditions prevailed. National forests in Wyoming and the Black Hills carried most permitted stock to the season's end. Outside ranges in Colorado and Wyoming presented a picture of forage desolation over millions of acres, and special emergency concessions were made on the Bighorn Forest. This helped relieve severe cases of distress. Livestock entered and left region 2 forests in good condition generally, although slightly light in weight when marketed.

In Arizona and New Mexico (region 3) climatic conditions were favorable except during the spring in southern Arizona. Feed was ample over most of the region. Except on the Coronado, summer ranges on the forests were better than for years. The calf crop was good, and percentage of lambs in northern New Mexico was the largest in years. Heavy snows during the winter of 1936–37 resulted in winter losses higher than normal.

Snowfall was heavy during the winter of 1935–36 in region 4 (Utah, southern Idaho, and most of Nevada) especially on outside ranges, but September to November 1936, was one of the driest periods of record. In the winter of 1936–37 many herds became snowbound on winter ranges, and Federal agencies extended material aid. On the forests, forage and livestock conditions compared favorably with 1935.

In California and western Nevada (region 5), precipitation was some 20 percent below normal south of the Tehachapi; for the rest of California it was 20 percent above. An unusually mild winter was followed by a cold and rainless spring and fall. Serious feed shortage was faced on lower outside ranges, but forest ranges were somewhat better than the previous year. Fires in northern California burned large outside acreages, contributed to serious fall and winter range and feed shortages, and materially interrupted financial recovery in that territory.

In region 6 the early winter of 1936–37 was difficult. Heavy snows in Oregon and Washington made early feeding of hay necessary, also heavy use of concentrates. Fall ranges, both on and off national forests, were dry with no fall growth of vegetation. There was, however, a favorable range outlook for 1937.

Market conditions.—Fall cattle markets were from $1 to $2 per hundredweight under those of 1935 for national-forest regions generally, but there was optimism among livestock producers except in areas that had experienced extreme drought or winter adversities. Values on stocker and feeder classes were penalized by feed shortages in feeder States. Adverse conditions slowed up liquidation on indebtedness in certain areas. With market improvements, and reduced interest rates and taxes, the general objective is for national-forest permittees to reduce or cancel their obligations as rapidly as practical. Easier private money and a tendency toward speculative phases have shown up in some sections. These influences are reflected in increased inquiries for national-forest range.

Range use.—In the calendar year 1936 the number of cattle permittees decreased 2 percent and the number of sheep permittees 3 percent; the number of cattle allowed to graze under permit decreased 2 percent, sheep 0.8 percent. Table 12 shows numbers grazed by States. In addition to stock under permits, 41,204 cattle, 48,585 horses, 12,317 sheep, and 909 goats were grazed in national forests under regulation authorizing free grazing of not to exceed 10 head of stock used for domestic purposes, or by prospectors, campers, and travelers, etc. For trends in range use see table 13.

Reductions.—Permit reductions in 1936 were again mainly for range protection made necessary by drought cycles and local overstocking. On nearly all national forests demands for range continue far in excess of range capacity. With growing limitations on grazing lands outside national forests, and at least until land-use planning and livestock production are better correlated with other agricultural production, this condition will continue to result in many applications that cannot be approved.

Reductions in 1936 for range protection totaled 3,139 cattle and horses and 32,097 sheep and goats, equivalent to 0.2 and 0.6 percent, respectively, of total numbers allowed in 1935. Reductions for distribution, totaling 715 cattle and horses and 5,063 sheep and goats, were largest in Regions 1 and 4. Reductions are applied first to temporary permits, which in 1936 covered 16 percent of the cattle and 13 percent of the sheep as compared to 18 percent and 14 percent, respectively, in 1935. Average seasonal use by cattle in 1936 was 5.7 months, and for sheep 5.1 months, against 5.3 and 5.1 months, respectively, in 1935. Usable national-forest area in 1936 was 88,878 net acres more than in 1935; the total 81,966,559 acres in the six western regions. Additions to national forests are mainly responsible for this increase.

Term permits.—No term permits were issued in 1935, pending readjustments in policy. Second series of 10-year term permits began in 1936, following policy approved by the Secretary of Agriculture on February 19. During the year 49 percent of the cattle and 55 percent of the sheep on national forests were grazed under this form of permit, issuance of which is governed by policy that provides: (1) Reductions for distribution, including those made in 1935, will not exceed 20 percent for the 10-year period 1936–45. (2) In any 1 year, no greater reduction than 5 percent will be made for distribution. (3) At the expiration of 1940, such reductions can be made for protection as the circumstances justify. (4) Protection and distribution reductions will be worked out separately. (5) All term permits will carry clauses determined by local conditions, specifying maximum reductions which may be made for distribution during the entire period 1936–45. (6) Reductions for all purposes during 1936–40, inclusive, will not exceed 30 percent, including reductions made in 1935; nor will they exceed 15 percent in any 1 year. (7) Adjustments to be made under this program will first be taken up with the local stockmen, and full consideration given their views.

Distribution survey.—Distribution survey was undertaken in 1935 on a representative national forest in each of the six western regions. It was expanded in 1936 to include cooperation by the Bureau of Agricultural Economics, the Division of Grazing of the Department of the Interior, and several western colleges. Field work on the initial project has

now been completed, although additional analysis of existing information is yet to be made.

This study was initiated to obtain factual information for use as a basis for policy determinations on allocation of national-forest grazing privileges, including such questions as land dependency, commensurability, protective and maximum limits, permittee qualifications, and related problems of importance. It was approached mainly through an analysis of range and other agricultural situations in and adjacent to areas selected for study. Social welfare and economic stability, usually closely related, and proper protection of the resource, are collateral objectives.

Findings in their various applications to range uses and indicated permit priorities and dependencies are now being discussed with livestock and related groups. It is hoped policies will be ready for application before issuance of national-forest grazing permits in 1938.

National-forest range resources are comparatively limited when measured against the total western range industry, which extends to about 75 percent more sheep and 85 percent more cattle than can be accommodated on the national forests. It is thus impossible to allocate a national-forest range to all who desire it. The distribution survey is attempting to reach logical and equitable answers to this situation, as well as to other major factors.

Western range conservation program.—Interest by livestock operators in range conservation and range management was given real impetus when the western division of the A. A. A. offered a range-conservation program to western livestock producers under authority of the Soil Conservation and Domestic Allotment Act of 1936. The Forest Service was requested by the A. A. A. to cooperate by examining ranching units, establishing grazing capacities, recommending conservation practices.

The program was formally offered early in September 1936. Response of western ranching operators was beyond expectations. By December 31, 29,858 applications involving 78,841,284 acres of privately-owned range land had been filed. This was approximately 22 percent of private, State, and county land which could qualify as ranching units. The Forest Service immediately proceeded to examine 56,329,422 acres of range land, establish its grazing capacities, recommend conservation practices for it. Methods employed were similar to those developed and used in similar work on national forests. Each report, in effect a simple, understandable statement of range-management needs of a ranching unit, was of immediate and direct benefit to owner or operator.

In the calendar year 1937 range-conservation program, about 35 percent of all qualifying western range lands have been offered for benefits. Because of its own administrative responsibilities, after the fall of 1936 the Forest Service furnished only a limited number of trained supervisory personnel. It also gave intensive training to those selected for the 1937 examinations, supervised their field work, and helped develop that manual of Technical Instructions for Range Surveys previously mentioned (p. 12).

Associations and advisory boards.—Local neighborhood livestock associations assure close and continued contacts between national-forest grazing permittees and forest officers. Annual meetings represent about the closest approach possible to a successful cooperative form of range management and administration. They provide opportunity for personal discussions of individual problems with permittees. At other meetings prior to opening of the grazing season range-program details are worked out. Pro rata assessments are voted for cooperative purchase of salt, hiring range riders, maintaining and constructing range improvements, and other features. Range-management plans are discussed. Mutual understandings are reached. Association advisory boards are constantly consulted by forest officers before adopting new or changing existing policies and practices having to do with administration of national-forest ranges.

The number of national-forest associations has increased steadily for many years. In 1936 there were 763, with 711 meeting all advisory-board requirements. Rarely has an association been discontinued when once organized. These organizations and their meetings have kept misunderstandings between permittees and the Forest Service to a minimum; resulted in worth-while accomplishments in actual range management on the ground.

Trespassing stock.—Progress has been made in better control of trespassing stock. In 1936 the total number dropped 35½ percent from that in the calendar year 1935. Better control is now possible by boundary fences and interior control fences built since emergency funds became available, including 6,996 miles of range fencing erected on the national forests since 1933. Tagging of permitted stock on areas especially susceptible to trespass has also given good results.

Livestock losses.—Table 14 shows livestock losses on national forests in 1936 and 1935. Predators continue as the largest single cause of losses in sheep and lambs. Tall larkspur is responsible for major losses in cattle. Eradication of it is generally by digging on areas of dangerous infestation.

Rodent control.—Rodent control, principally under the cooperative direction of the United States Bureau of Biological Survey, extended to 581,456 acres in 1936. Total area treated to date is now more than 13,760,000 acres.

Range surveys.—During the calendar year 1936, 3,366,459 acres were covered by intensive range surveys. Including resurveys of certain earlier and less intensive work, the total to date is now some 70,877,000 acres. Effectiveness and accuracy of aerial surveys in providing cultural data for basic ground maps in difficult terrain makes it possible to supplant much of the older ground-crew method of surveys. Good cultural maps have a primary value in providing the basis for management of individual national-forest range units, of which there are 4,325 now devoted to use by cattle, and 4,783 by sheep.

WILDLIFE MANAGEMENT

Wildlife management is a major national-forest activity. With other resources, it is managed on the multiple-use principle, modified where necessary by special programs determined by regional and local conditions and needs. National-forest wildlife resources now include some 1,600,000 big-game animals; an equivalent number of fur bearers; game birds; about 70,000 miles of trout streams; game fish in natural and artificial lakes and ponds that total thousands of acres.

About 75 percent of the big game in Western States depends upon national-forest summer range. Estimated numbers by States will be found in table 15. Possibilities of national-forest wildlife production are not limited to current numbers of game, fish, fur bearers, and birds. Average increase of big-game animals has been fully 140 percent since 1924, despite more hunters and regular open seasons on deer and, more recently, on most elk herds. But winter ranges within the forests, particularly in Western States, are relatively limited and very little outside winter range is now available for game. So as game increases, the winter-range situation becomes a controlling factor in the numbers of big game that can be cared for. In recent years at least 18 important winter problem areas have developed within national forests.

Analysis of range for wildlife, made in 1936, discloses the need of some 9,000,000 additional acres of winter range in the Western States to provide adequately for present numbers of big game. In addition, about 25,000,000 acres would be needed properly to take care of deer and elk, estimated at several times the present numbers, that national-forest summer ranges could support.

Game refuges.—At the close of the calendar year 1936, State game refuges within national forests totaled 349, their total area being 21,277,964 acres. There were also 31 Federal refuges comprising 4,080,600 acres, and 120 areas totaling 4,139,818 acres set apart by the Forest Service under administrative restrictions in the special interests of wildlife.

Refuges have proved helpful in the initial stages of game protection, but can and frequently do get out of hand through overpopulations of game unless positive measures of management and control are applied. With such management the need for large refuges becomes progressively less.

Cooperation.—Formal cooperative relations with the Bureau of Biological Survey and the Bureau of Fisheries, directing wildlife research work on national forests within their respective fields, were extended during the year. The Biological Survey cooperated in adapting forest improvement cuttings to wildlife needs. The Bureau of Fisheries secured technical data on which to base programs for improving national-forest fishing resources. It also studied Lake States locations with a view to supplying more adequate hatchery facilities in that territory. Special accomplishments included a rearing station and laboratory of 200,000-fingerling capacity on the Pisgah National Forest and Game Preserve, N. C.; additional ponds at Arrowwooddale, N. C., to give the plant there an added capacity of 60,000 fingerlings; 40 more ponds with an additional capacity of 800,000 fingerlings at the Wall Hollow C. C. C. cooperative project on the Nantahala Forest, N. C.; and completion of a large hatchery plant on the Teton Forest, Jackson Hole, Wyo., with an annual capacity of 2,000,000 eggs.

Organization—In 1936 a *Division of Wildlife Management* was installed in the Washington office. Though wildlife activities necessarily fall in large part upon regular Forest Service personnel, 83 specialists were employed in 1936 on wildlife assignments. Functioning in most of the 10 regional offices of the Forest Service, 69 of them were trained in colleges and universities; the remainder were qualified through extended experience in the wildlife field.

About 1,500 regular forest officers participated in wildlife activities. Work programmed and accomplished includes counts and estimates of game, extensive fish plantings, studies of food and other habits, winter patrols, game hunts on Federal refuges, raising and transplanting fawns and capturing native deer on the Pisgah Federal refuge, transplanting beaver, development and initiation of cooperative agreements with States, detailed reports to cooperating agencies, and collection of data basic to management plans.

In wildlife management every effort is made to cooperate with and through different Federal, State, and other agencies, so that there may be a united and effective effort to better wildlife conditions on the national forests.

RECREATION

In effect the report to the President of his subcommittee on recreation (p. 11) recognizes national forests as a major source for outdoor recreation of inestimable social value; indicates that, already used by millions, this resource should be promoted and developed to help meet rapidly increasing national needs and demands; believes the fundamental principle of territorial integrity should govern in actual administration of recreational and other resources by Federal land-administrative agencies such as the Forest Service.

A planned forest-land use.—Until comparatively recently recreational enjoyment of forest areas in this country has been largely incidental. It is now much more than this. Instead of living in the forest, we now go there to enjoy ourselves. Forest recreation has definite values in our lives, and we want it included as a planned forest-land use.

Increasing use of national forests proves this. In 1916 they were visited by some 3,000,000 people. In 1937 people who actually used planned recreational facilities and areas included 857,359 special-use summer-home permittees and guests; 2,165,329 hotel and resort guests; 2,836,040 campers; 5,973,930 picnickers; and 18,969,280 who motored, rode horseback, and hiked, primarily to enjoy scenery and cool forest climate. The 1937 total, 30,801,938 people, does not include motorists who merely passed through en route to other destinations.

Scenic values.—When national-forest scenic or recreational values are paramount, they may be given a dominant position in land and resource use. As a rule, however, recreation in national forests is developed as one of many uses; is correlated and harmonized with existing or potential uses of other resources upon which almost one million people already depend for their daily bread and butter. The Forest Service encourages and develops simple forms of recreation; those easily available to people of limited means. To keep facilities in harmony with forest surroundings it has employed some 75 professionally trained landscape architects who, in the field, design and supervise construction of public camp and picnic grounds, fireplaces, tables, council rings, children's playgrounds, etc. Most of this work has been financed from emergency funds. To continue it, and properly to administer the recreational resource, regular appropriations larger than have been available in the past will be required.

Preserving roadside beauty.—Administrative policy requiring that strips of timber be left along forest roads is now bearing fruit. Because of it many roadsides are now bordered by areas of natural forest beauty. This policy will be continued and expanded. Through Federal acquisition of suitable strips, by purchase or exchange, it will wherever possible also be extended to forest lands which, now privately owned, may otherwise be subject to exploitation.

WATER POWER

Present estimates place one-third to one-fourth of all our water-power resources within national forests. In addition there are hundreds of irrigation projects, many small and scores of large municipal water-supply systems. Protected national-forest watersheds help all these, as well as projects for power, irrigation, navigation, flood control, and domestic water hundreds of miles away.

During 1937 the Federal Power Commission received 41 applications for permits or licenses involving use of national-forest lands. This was 73 percent of the total number filed under provisions of the Federal Water Power Act.

When the year closed the Forest Service, acting for the Federal Power Commission, was supervising operations under 407 water-power permits and licenses. Monthly reports on applications for permits, licenses, amendments, and construction, covered 146 cases. At the end of the year 184 permits and easements issued by the Department of Agriculture through the Forest Service prior to the enactment of the Federal Water Power Act were still in effect. Of these, 87 were power projects with a total estimated average low-flow output of 358,969 horsepower and total estimated installed capacity of 725,000 horsepower. Ninety-seven covered transmission lines with a total length of 840.91 miles within national-forest boundaries.

Annual rental fees were involved in 46 power projects, with an estimated low-flow output of 333,774 horsepower, and in 83 transmission-line cases with a length of 737.71 miles. No rental fee was required for 41 power projects with an estimated average output of 25,195 horsepower, and 14 transmission lines with a total length of 103.20 miles.

ROADS AND TRAILS

Mileage of the proposed national-forest transportation system is shown in table 2. This system embraces only those roads and trails which have been approved and are to be included in definite construction programs. Funds available for construction of forest roads and trails during the fiscal year 1937 included:

(1) The 10-percent fund, known as the "roads and trails for States, national-forest fund", available annually under provisions of the Agricultural Appropriation Act of March 4, 1913.

(2) Forest road and trail fund, composed of forest highway and forest road development funds, appropriated under section 23 of the Federal Highway Act of November 9, 1921.

(3) Cooperative funds, provided mostly by the States.

Tables 4 and 5 show distribution among States of various road and trail funds for the fiscal year 1938, and total distribution. Table 6 shows condition of these funds at the close of the current fiscal year.

Forest highways are necessary primarily for public travel; truck trails and others primarily for national-forest protection, administration, development, and utilization. Table 3 shows, by States, the miles of forest highway, truck-trail and trail construction and maintenance, with expenditures to June 30, 1937.

Contributed time of agencies other than the Forest Service, evaluated at $24,175,799, was used in constructing and maintaining forest truck trails and trails. Most of this was by the C. C. C., which from national-forest camps constructed 2,517 miles of truck trails and 325 miles of other trails; maintained 26,231 miles of the former and 11,458 miles of the latter.

Work on selecting an economical road surface for dirt roads, to help eliminate dust and loss of surface material, has been continued. Experiments in the use of calcium chloride and sodium chloride applied to stabilized earth surfaces indicate the desirability of greater use of these methods on more heavily used truck trails. Appropriate signs with information useful to the public, and forest entrance markers, have been constructed on many important roads.

State and Private Forestry

When white men first came, forests in what we now know as the United States grew on about 820 million acres. Lands most valuable for forest purposes still total about 615 million acres. This is almost one-third of our continental land area.

These forest lands are divided into two broad classes—those at present noncommercial, and those now commercial. The former total 120 million acres. Broadly speaking, private owners are not much interested in them, but because of public values for such things as recreation and watershed protection, State and Federal Governments are. Commercial forest lands, capable of growing timber now marketable, total 495 million acres. These are the ones in which private owners are particularly interested, and they now own the best four-fifths of them. The poorer one-fifth is in public ownership.

The manner in which all forest lands are handled is vital to the Nation as well as to individuals. Exploited and mined, forests disappear; under planned management, producing continuous crops for harvest, they can help maintain industries and communities permanently.

One Forest Service job is to protect, develop, and administer the Federally owned national-forest system. Because of the many public interests involved, another is to encourage and help establish adequate management on forest lands in State and private ownership.

STATE COOPERATION

In Massachusetts, early forest legislation grew out of encroachment by sand dunes near Truro, on Cape Cod, said to have been brought about by cutting timber and permitting domestic stock to graze on seaside commons. To help save Pennsylvania's forests, thrifty William Penn's original Charter of Rights provided that, in clearing ground "care should be taken to leave one acre of trees for every five acres cleared * * *." Such measures were in large part limited and local. Since then real progress has been made in forestry legislation by the States.

Progress in State forestry legislation.—The year's forestry legislation among States may in general be grouped as indicated below. Its volume makes inclusion of details in this report impossible.

That affecting State forest organizations.—Colorado placed forestry activities under a board of land commissioners. Georgia created a department of natural resources with four divisions, one of which is forestry. Minnesota replaced its conservation commission by a single governor-appointed commissioner. Missouri created a four-man conservation commission which selects its own commissioner. Oklahoma replaced the State Planning Board, Conservation Commission, and Forest Commission by a planning and resource board employing a director of forestry. Oregon added to its board of forestry one member representing the Western Livestock Association and the Oregon Cattle and Horse Raisers' Association. Tennessee transferred its forestry work to a new department of conservation. Colorado, Georgia, Oklahoma, and Tennessee required the State forester or his equivalent to have technical forestry training and/or experience. Maine excepted officers and employees of the forestry district from a newly established classified service based on merit and fitness.

That affecting State and county forests.—Alabama, Connecticut, Georgia, Idaho, Illinois, Indiana, Missouri, Montana, New Hampshire, Oklahoma, and Tennessee authorized (1) agreements with the Federal Government for purchasing land in their behalf, (2) expenditures for administering such lands as State forests, and (3) reimbursement to the Federal Government for cost of the land from proceeds secured from such forests. Connecticut authorized leasing of forest lands from former Resettlement Administration or other Federal agency, and North Carolina the purchase of land to complete an area already partially acquired for State forest use. Oregon granted counties powers to acquire and administer county forests. Pennsylvania limited the amount of delinquent taxes which counties might claim for reimbursement on lands ceded it for State forests.

Florida, South Dakota, Tennessee, and Washington provided for clearing title to tax-delinquent lands suitable for State forests. Idaho, Indiana, Massachusetts, Minnesota, New Hampshire, South Carolina, Tennessee, and Washington facilitated administration of State forests. Iowa financed State forest acquisition and participation in emergency conservation activities. Arkansas allocated its severance tax on timber to the forestry fund.

Wisconsin increased its State tax for financing forestry work. Connecticut and Pennsylvania reenacted and amended laws relating to reimbursement of the Federal Government from direct profits from C. C. C. projects.

That enabling creation or extension of national forests.—Georgia authorized purchases for national forests in certain additional counties. New Mexico, in addition to authorizing such purchases, recommended that all Federal timberlands within the State be administered on a sustained yield basis. Tennessee added the requirement that the State forester as well as the Governor must approve Federal purchases for national forest, park, or certain other purposes. Illinois, Minnesota, Oklahoma, Oregon, South Dakota, and Washington authorized exchanges of land between State, county, and Federal Governments. Oklahoma authorized conveyance of specific areas to the Federal Government.

That affecting disposal of State forest resources.—Illinois authorized sale of planting stock not required for State forests, under terms enabling the State to get cooperation under section 4, Clarke-McNary law. Nevada prohibits taking trees, flowers, and shrubs without permission. Minnesota and Washington placed traffic in Christmas trees under license control, with tax of 1 cent per tree in Washington and 2 cents in Minnesota. Wisconsin imposed a penalty for failure to give notice of intent to cut Christmas trees. Colorado authorized sale of timber on State lands, with logging under approved forestry practices. Minnesota provided for clearing and cultural treatment of roadsides.

That regulating cutting on private lands.—Idaho provided for cooperative sustained yield districts, established rules of forest practice for different forest types and age classes, and granted exemption from taxation to young growth and seed trees left for conservation purposes after logging. Tennessee authorized establishment of cooperative sustained yield units composed of privately and/or publicly owned forest lands.

That affecting taxation of forest lands.—Alabama extended tax exemption to capital stock of domestic corporations represented by standing-timber values on their classified forest lands. South Dakota and North Dakota amended and reenacted tree-bounty laws. Wisconsin modified its general tax law relating to exemption of farm woodlands and slope lands, and its forest-crop law in relation to village and county forests. New Mexico imposed a severance tax on the value of timber cut. Connecticut provided for grants to towns in lieu of taxes on lands leased by the State for forest and park purposes.

That affecting forest-fire protection.—Utah created a State Board of Fire Control, provided for fire districts, declared uncontrolled fires a nuisance. Nevada provided for county fire-patrol districts. Oregon authorized county committees to classify forest land, with special provisions about clearing and burning. South Carolina provided for forest-fire control districts in Lee, Greenville, Colleton, and Marion Counties, and for annual payments by counties to the State for the work. North Carolina added Roanoke Island Fire District to its fire-control system. Washington provided more specific authority to employ and suspend fire wardens, and extended their authority. Georgia authorized wardens to enforce State fire laws.

Oregon extended its closed fire season by 3 months. Washington authorized the Governor to proclaim a fire season different from that stated in the existing law, and to close logging, land clearing, and other industrial operations in extreme hazards. North Carolina established a closed fire season with permit system from April 1 to June 15, applicable to organized protected areas only. Indiana makes a permit necessary for burning within ½ mile of any land acquired by the United States. Utah authorized its chief warden to declare a closed fire season when conditions demand. Georgia authorized fixing a period during which woods may be burned over in a period not to exceed 30 days in any calendar year. Connecticut modified restrictions requiring permits for kindling fires in the open. Minnesota authorized closing roads and trails built by the division of forestry and not intended for public highways, when necessary for fire prevention. Utah's chief warden may close areas to all forms of use in emergency. The Governor of Illinois may close definite areas to persons making open fires, except under permit.

Oklahoma, South Dakota, Wyoming, Utah, and Wisconsin prohibited the dropping of cigarettes or other burning material under specified conditions. Wisconsin, Utah, and Oklahoma made willful and malicious setting of fire a felony. Georgia made uncontrolled fire a public nuisance and provided that in case responsible parties refused or neglected to control and extinguish them, organized fire suppression forces might do so and recover costs. Washington strengthened its laws relating to spark arresters, and responsibility of timber operators. South Dakota amended two code sections defining the responsibility for and control of prairie and other fires. Alabama provided that an informant making affidavit of violation of chapter 142, 1923 code—relating to forests and woods burning—be paid one-half the fine up to $25. Oklahoma improved its forest-fire laws, and Idaho strengthened its slash-disposal law.

That affecting forestry within soil-conservation districts.—Compulsory preventive and control measures relating to forest practice when essential to soil conservation may be invoked under the standard State soil conservation district law as prepared by the United States Department of Agriculture. Such a law was adopted, entire or in modified form, by 22

States as follows: Arkansas, Colorado, Florida, Georgia, Indiana, Kansas, Maryland, Minnesota, Nebraska, Nevada, New Jersey, New Mexico, North Carolina, North Dakota, Oklahoma, South Carolina, South Dakota, Utah, Illinois, Michigan, Pennsylvania, and Wisconsin.

Cooperation in protecting State and private forest lands from fire.—Seventy-six percent of our forest land is so situated that it needs organized protection from fire. During the calendar year 1936, almost three-fifths of this area was under some form of organized protection. This is 9,662,400 acres more than in 1935. A total of $4,778,544.73 in State and private funds was expended on this cooperative forest-fire protection work in 1936. Other undetermined sums were spent by private owners acting independently. Cooperative expenditures for fire protection under the Clarke-McNary Act are summarized in table 17.

The area of State and private forest land reported burned over during the year was 42,782,420 acres. More than nine-tenths was outside organized protection units; less than one-tenth within them. Of protected area burned, 2,698,050 acres were classed as having productive values. Number of fires reported on protected areas was 73,709, an increase of 19,117, due largely to unfavorable weather conditions and increased recreational use.

The C. C. C. made real contributions to fire protection on State and private forest lands, constructing on them 25,350 miles of telephone line, 37,147 miles of firebreaks, 41,922 miles of trails and truck trails, 500 lookout towers, and 651 lookout houses to March 1937.

Total funds from all sources budgeted for the fiscal year for fire protection on State and private forest lands was $7,083,306. This was nearly $1,000,000 more than for the previous fiscal year, yet 175,000,000 acres still lack adequately organized fire protection. Analysis indicates that reasonably adequate protection for all the 427,000,000 acres of State and private forest land that should have it may require approximately $18,000,000. Appropriations for State cooperation, 1936–38, are given in table 16.

Cooperation with States in tree planting.—The calendar year 1936 witnessed the largest number of trees ever produced and distributed by States for planting by private landowners under section 4 of the Clarke-McNary law. Total, 35,647,809 trees, was an increase of 37 percent over the previous year, and 6,500,000 trees more than during any previous similar period. In addition to improving existing stands, about 36,000 acres were added to woodlands and forest plantations on farms during the year. In all, 40 States and 2 Territories cooperated. For distribution of expenditures, see table 17.

Farm forestry.—On May 18, 1937, President Roosevelt signed the Cooperative Farm Forestry Act (Public, No. 95, 75th Cong.). Coming as a result of widespread interest from rural areas generally, carrying an annual authorization of $2,500,000, and authorizing cooperation in the development of farm forestry in States and Territories, this legislation should give real impetus to forestry on farm wood lots now owned by more than 2,500,000 farmers. The bill provides for such specific activities as growing and procuring tree and shrub planting stock for reforestation and afforestation; advising farmers on protection and management of forests and on harvesting, utilizing, and marketing the products thereof; and investigations in farm forestry. Basic cooperative policies have already been discussed with the Extension Service, the State foresters, and other agencies.

Several farm-forestry projects in addition to normal cooperative work under section 5 of the Clarke-McNary law were conducted during the year. Timber inventory for a cooperative farm woodland project on either side of the Vermont-New Hampshire line was nearly completed. A similar project was started in south-central New York. Preliminary reconnaissances were made of areas suitable for cooperative marketing in Massachusetts, Pennsylvania, Virginia, and West Virginia. In Mississippi an extensive report was completed on sustained yield possibilities of an area of 2⅓ million acres of mixed ownership involving a high proportion of farm woods centering around a large wood-using plant.

Rural prosperity in the South is closely associated with forest practices by the pulp and paper industry, which gets much of its current forest needs from open-market purchases from farm woodlands. There is real need for better forest practices to protect these woodlands and to assure to farmers continuous yields at fair prices. For further discussion of this situation see pages 13 and 28.

Cooperative arrangements have been made with the Extension Service and the C. C. C. by which demonstrations of thinning and stand-improvement practices can be accomplished on areas not exceeding 5 acres each. The objective is visual presentation of better woodland practices and integrated utilization providing pulpwood, fuel wood, poles, piling, and quality sawlogs.

Technical advice on forestry practices was given the A. A. A. in connection with that part of the agricultural conservation program having to do with benefit payments for approved forestry practices.

Cooperation with States in farm-forestry extension.—Activities in cooperative farm-forestry extension authorized by section 5 of the Clarke-McNary law are conducted as part of the extension program of the various State agricultural colleges, and are administered by the Extension Service. The Forest Service gives cooperation and technical assistance. During 1936, 36 States and 1 Territory participated. Forty-six forestry specialists are employed in field work. Field demonstrations and meetings during the year totaled 11,543,

a 34-percent increase over the previous year. Expenditures for the fiscal year were $48,323.51 of Federal funds (Clarke-McNary) and $103,730.12 of State funds.

A Nation-wide system of State forests.—No appropriation was made under the Fulmer Act (49 Stat. 963) for the fiscal year. In cooperation with States the Forest Service continued, however, to develop a program so that acquisition of land suitable for State forests may proceed without delay when funds are made available.

When the Fulmer Act was first enacted few States were qualified under its provisions. Thirty-six States now appear to be qualified, and prompt application for cooperation may be expected as soon as funds are available. The list includes: Alabama, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Montana, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, Washington, West Virginia, and Wisconsin. Areas specifically proposed for State forests under the Fulmer Act were cooperatively examined in 14 States—Arkansas, Connecticut, Florida, Louisiana, Maryland, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Tennessee, Texas, Vermont, and Virginia. Complete reports were prepared in each case. The net purchasable area covered was 8,042,047 acres. Examinations and reports in cooperation with other States are now being made.

PRIVATE FORESTRY

Private owners, with more than 380 of the nearly 400 million acres of their commercial forest lands still without adequate forest management, hold the key to our forest situation.

In helping solve this problem the Forest Service has (1) studied individual ownerships and combination of ownerships, both private and public; (2) cooperated with States and organized groups of forest industries; (3) analyzed factors affecting the success or failure of private forestry; (4) made extensive surveys of political units; and (5) explored aspects of State and Federal legislation affecting forestry practices by private owners. The underlying purpose has been to promote better forest practices, including sustained yield.

In all, more than 50 case studies have been made, largely in the South, the Lake States, and on the Pacific coast. Sixteen more are under way. These studies are followed by conferences with interested parties, and by field demonstrations. As a result, some private concerns have revised their cutting budgets and methods of cutting to bring them more nearly in line with the potential capacity of their lands for sustained production. Preliminary survey of forest practices on industrially owned forest lands indicates that only 3 percent of those lands is now managed on a sustained-yield basis. An additional 7 percent is now being left in good growing condition after logging.

The lumber industry.—It will be remembered that in 1934, under a National Industrial Recovery Act code, the lumber industry committed itself "to conserve forest resources and bring about sustained production thereof." After a conference of industry and public agencies called by the Secretary of Agriculture, regional rules of minimum woods practices were adopted and accepted, with administration by organized industry. The President appointed the Chief of the Forest Service as one of three nonvoting members of the code authority. Through a skeleton organization, the Forest Service then provided for cooperative inspection of woods operations, and technical advice in enforcement of woods-practice rules in connection with code forestry requirements which, effective June 1, 1934, were terminated when all codes were abolished on May 27, 1935.

In April 1937 the organized lumber industry held a conference to review its woods practices, recommend such further developments in them as might seem desirable and practicable, review public activities and legislation in forest conservation, and recommend public action that might support and give effect to industry's program.

Purely in an advisory capacity, but as an interested public agency, the Forest Service attended this conference. By request it submitted comments on woods rules and practices then in effect by industry. It also subscribed to industry's forest-practice objectives as there stated, questioned the possibility of attaining them through purely voluntary action, and suggested the program outlined on pages 6–8. Public regulation, with responsible local representation and provision for appeals, and always kept within the typically American democratic pattern, was one of the three points suggested.

Paper, prosperity, and the South.—From 1926 to 1936 the annual consumption of sulphate pulp in the United States increased from some 900,000 tons to 2,500,000 tons—more than 170 percent. From 1935 to 1936 the increase was approximately 20 percent. In 1925, 43 percent of the domestic sulphate pulp consumed was imported, but by 1936 imports had dropped to 29 percent. Indications are that there may be available by 1938 some 3,660,000 tons of sulphate pulp annually, or 50 percent more than the estimated consumption in 1936.

In the South, 13 new pulp and paper mills with plant investments of around $100,000,000 and planned annual capacities of about 1,500,000 tons of pulp are now projected for early

production. This requires some 2,500,000 cords of wood a year. Reasons for this concentration are relatively cheap labor, deep-water shipping facilities, and a plentiful supply of wood at relatively low costs.

Certain companies own or control some forest land, but they rely largely upon pulpwood secured principally from farmers. Transportation costs ordinarily confine wood supplies to an area not more than 150 to 200 miles from any given plant. In about half the South there are extensive areas where existing industries are already using more wood than is replaced by annual growth each year. This eats into assets needed to keep forests productive. Superimposing new pulp and paper plants upon already established industries means that without some form of intelligent management certain areas may be left in unproductive condition for generations.

Such a situation is neither in the public interest nor that of wood-using industries. A friendly warning has been issued. The picture is admittedly complicated, involving many factors such as an intricate pattern of forest-land ownership, thousands of wood-using plants with varied requirements and national and world-wide markets, and huge forest areas that have already been exploited. State foresters and the Forest Service are cooperating with individuals and groups. The American Pulpwood Association has suggested minimum woods-practice rules. If applied to all lands from which pulpwood may be secured, these rules may prevent the suicidal practice of clear cutting, and in that respect may be counted as some advance. But as now constituted, these rules fall far short of the association's announced objective of building up forest growing stock, which is the crux of the situation.

Prairie States forestry project.—Up to June 30, 1936, 1,277.8 miles of shelterbelt strips had been set out, 6,474 acres of farmstead plantings established, 23,771,061 trees, cuttings, and nuts planted. Average survival was 81 percent. On that date there were also 75,000,000 seedlings growing in nurseries, an insistent demand for them, a pressing problem of work relief for drought-stricken families, and only $170,000 made available by Congress for liquidation purposes. With emergency funds from the W. P. A., 18,246 man-months of employment were given during the fiscal year to needy local citizens on relief rolls, and carry-over nursery stock was used. This saved heavy investments already made.

Cooperative agreements executed this year required larger contributions by the landowner than in the past, yet there was a greater demand for nursery stock than could possibly be supplied. This was due, perhaps, to those living windbreaks which tell a story that cannot be refuted. In addition to the stock planted (table 18), this project furnished nearly 9 million seedlings to other Government agencies during the current year.

Naval stores conservation program.—In 1936 and again in 1937 the Forest Service was assigned by the A. A. A. with responsibility for technical performance standards and field inspections required in the naval stores conservation program authorized by the Soil Conservation and Domestic Allotment Act. The work was localized in the South, where production of naval stores for world markets is centered.

The 1936 program was announced in July, when producers were in midseason operation. It provided primarily for discontinuance of faces on small-sized trees, and other uneconomic faces, with maximum discontinuance on any one turpentine place or farm of 25 percent of all operating faces. Fire protection and good chipping practices were also required.

For the calendar year 1936, 921 operators filled in work sheets listing 78,627,209 operable faces. Of these, 14,286,678 were listed for withdrawal from production under terms of the program, and final payment was made on 13,553,321 faces so withdrawn.

The 1937 program, conducted on a calendar-year basis, was announced in December 1936. This was before most producers had started 1937 operations. For that calendar year, work sheets were filed by 1,060 operators representing about one-third of all estimated operating faces. This was only approximately 60 percent of the anticipated participation. The number of faces listed on 1937 work sheets was 49,711,020. Of these, 1,898,567 were to be withdrawn from production under terms of the program. Final payments have not yet been made.

Research

To be permanent and to contribute regular net returns in service, money, or both, forest-land management must rest on sound technical and economic bases. This applies to public and private ownership alike. Recognition of it is evidenced by increasing demands for information based on forest research. Existing knowledge, however, falls short in many cases of what is really needed adequately to guide policies, programs, and action.

FOREST ECONOMICS

Research in forest economics serves both public and private needs. Land management is invariably confronted with the responsibility of equitable disposal and use of forest-land products and privileges. For more than three decades the Forest Service has adhered to the policy, on national forests, of multiple-use land and resource management. In the words of a former Secretary of Agriculture, it has consistently held that "forests are to be devoted to their most productive use for the permanent good of the whole people, and not for the temporary benefit of individuals or companies."

Prescriptive rights.—From time to time national-forest users want irrevocable rights to certain uses, such as grazing. Stabilization of business is the argument usually advanced. A study of experiences in older countries, where vested rights have been granted, indicates that grazing and other uses have a legitimate place in balanced multiple use of forest land, but only if they are kept under control by the owner or agency responsible for forest-land management.

Existence of such rights, however innocuous at the start, has almost without exception become a serious impediment to efficient forest management. In many countries it has led to destruction or impairment of the productive capacity of forest lands. Where such rights are established, most countries have to go through long and costly adjustments to safeguard public interests. In almost every case, establishment of prescriptive rights to forest lands has been economically and socially undesirable. The conclusion is inescapable that they make it impossible to adapt many forest-land uses to changing needs of dependent communities, forests, and users. A report on this study, particularly as it bears on our own future policy, is in press.

Land utilization.—In broader phases of land economics, studies of forest-land ownership and use, and of tax delinquency and reversion of ownership, provide guidance for public acquisition programs. In the Douglas fir region such studies are now assisting State and county officials in preparing policy to govern use and disposition of tax-forfeited forest lands.

Land-utilization studies in cooperation with the Giannini Foundation were continued in California's Sierra foothill counties. Results are being used by State and Federal planning agencies. To be successful, solution of the problem must help stabilize tributary community life dependent on permanent resource management. On private and public lands involving coordinated use for agriculture, range, and forest production, it must also correlate uses. Crystallization of such plans inevitably raises the question whether private ownership of forest and wild lands will recognize and redeem its public responsibilities, or whether public ownership of certain areas is necessary adequately to protect public interests.

In the Lake States compilation of tax-delinquent areas was continued and some correlation of tax forfeiture and the kind of land involved was made. Here are some 12 to 15 million acres of "no-man's land" that, interspersed with State and Federal holdings, urgently need rehabilitation as part and parcel of a public acquisition program. Study in the Yazoo Delta of the Mississippi indicates that heavy drainage and land taxes are a stumbling block to private ownership there.

Forest-fire insurance.—Forest-fire insurance is practicable in the Northeast and is a feasible commercial undertaking with proper observance of underwriting principles. A bulletin giving results of an intensive forest-fire study in the Pacific Northwest is now contributing toward the development of forest-fire insurance.

Timber management.—Economic studies of timber management in the Douglas fir region involve such problems as investment requirements for an adequate growing stock under sustained-yield management. So far, it appears that about one-third the existing growing stock has no present realizable commercial value and hence involves no investment

burden; one-third is of low value and on current valuation justifies only small investment burdens; one-third or less is of such high investment value as to create pressure for immediate liquidation.

Ponderosa pine studies have led to decided changes in logging on public lands. These changes provide for removal of only 30 to 40 percent of the volume during the first cut, as compared to 60 to 80 percent under former practice. An important factor facilitating this procedure is the revolutionary change from railroads and skidders to truck and tractor logging.

With studies to demonstrate the economic feasibility of light cuts at short intervals in stands of virgin and second-growth shortleaf and loblolly pine, the possibility of integrated utilization has also been investigated. Results, where a private company follows the plan of light cuts, sends better quality logs to the sawmill, poorer ones and low-quality material from tops, limbs, and thinnings to the pulp mill, indicate (1) better returns than under clear cutting and (2) an opportunity to build up depleted forest growing stock. Such modifications will yield benefits in community stabilization, and larger continuous economic and social returns from the forest. With truck transportation, light cuts of only 500 board feet per acre cost practically the same per thousand as when 4,000 board feet is removed.

Pulpwood.—If pulpwood requirements are supplied so far as possible from stands handled under light cuts, with integrated utilization of the timber removed and coordination with the needs of existing timber-using industries, investigations show that planned pulp expansion in the South can be a constructive economic force in bringing closer utilization and improved forest practices. Production-cost work shows that low-quality material from poor trees and tops is acceptable for pulpwood, and can be handled at a price to yield a fair margin for profit and stumpage.

Forest taxation.—Advisory service was continued to States interested in application of sound principles of forest taxation. Major effort was given to a study of what can be done to improve fiscal arrangements between Federal and local governments in approximately 500 counties where national forests are located.

As partial reimbursement for loss of revenue due to tax-exempt status of national-forest lands, local governments are now granted money payments of 25 percent of the gross receipts from these properties. Local governments also benefit from national-forest activities involving construction of local roads, and through stabilization of local industries dependent on national-forest resources. The 25-percent contribution has, however, been found unsatisfactory in some respects.

Comprehensive study of this problem resulted in formulation of two alternative plans. Both have the following objectives: (1) To stabilize contributions on account of national forests created from the public domain, and to distribute such contributions more equitably without making any marked change from the aggregate amount now allowable by law in each State; (2) to provide adequate annual contributions to taxing districts containing those acquired national forests from which realization of substantial receipts will inevitably be delayed either because the lands had been cut over before acquisition, or because cutting in the early future would be contrary to sound public policy.

The Forest Survey.—The task of rapidly covering and reporting on three-fifths of a billion acres of forest land is a big one. With the help of emergency funds, the Forest Survey made tangible progress in field work within six regions during the year. Less headway was possible in office work.

Field work covering 51 million acres was completed for the Pacific Northwest. About 2,000 copies of detailed forest-type maps covering Oregon and Washington (except the northeast quarter of the former) have been lithographed. A report for the Douglas fir region is nearing completion. Preliminary reports for 14 counties in the Oregon-Washington pine region were issued. In the Douglas fir region forest increment is at least twice that previously expected; and total volume of timber is about equal to previous estimates.

The northern Rocky Mountain area includes some 37 million acres. It is closely allied in regional planning with the Pacific Northwest. About 50 percent of it has now been mapped and inventoried. Absence of satisfactory growth figures required preparation of normal yield tables for the larch-Douglas fir type, and collection of stocking information to adjust existing white pine and ponderosa pine tables to average stand conditions. Work is nearest completion in northern Idaho and northeastern Washington. Two preliminary county reports for northeastern Washington have been issued. For the area studied, type maps have been prepared. Regional cutting depletion compilation has been finished, and additional information compiled on requirements for farm buildings, fuel wood, and fence posts.

In California 29 out of a total of 72 million acres have been type-mapped in the field, 10 vegetation-type quadrangles have been lithographed, and 12 more are about half completed. Type maps are of immediate value in planning fire control, and recreational and utilization improvements. They will be indispensable to the inventory phase of the survey.

Forest survey field work in the Lake States is now virtually completed. Office computations and analyses are not far behind. A publication for Minnesota is in preparation, as are generalized forest type maps for timbered parts of Minnesota, Michigan, and Wisconsin.

Preliminary estimates indicate some 50 percent more timber volume in Minnesota and Michigan than previously supposed. A good part of this is scattered, of minor species, and economically unavailable. Virgin timber is limited, and local shortage seems inevitable during the next few decades. The big problem here is to husband what is left until second growth reaches maturity. Data show growth several times larger than previous estimates. Some must be reserved to build up depleted growing stocks, so not all of it is available for cutting.

Field work in the Appalachian territory was initiated this year on a fully organized basis. Some 26 million acres—or one-third the territory's total forest area—has been cruised. Growth and depletion studies are just getting started. A progress report for the Tennessee Valley Authority, concerning Norris Dam watershed, and a release for part of South Carolina, have been issued.

In the South, effort was focused upon compilation, analysis, and interpretation of the enormous volume of forest information already collected for the 129 million acres studied. Six preliminary reports were issued. Additional forest information was supplied many public and private agencies and individuals. Much of this was in connection with pulp-mill expansion. On an area basis, preliminary figures for 83 million acres indicate 6 percent of virgin timber; 49 percent of old growth partly cut and second growth of sawlog size; 30 percent of second growth below sawlog size; 5 percent of reproduction; and 10 percent of nonrestocked and scrub hardwoods. More than three-fourths of the forest area, and nearly three-fifths of the timber volume, are second growth. Forest stocking is below normal, and a part of the current growth must be retained annually if depleted forests are to be built up.

Present and future requirements for timber have now been studied for all major classes of wood use. The next step is to analyze probable national requirements and trends on the basis of information collected. It seems probable, for example, that due in large part to submaintenance during the past half decade, farm demand for lumber may exceed 6 billion board feet annually. Wood is still the leading material in residential construction, but use of it in automobiles and refrigerators has dropped sharply. In furniture, wood is more than holding its own. Declining demand for naval stores has brought an excess supply of turpentine, a situation that must be changed if the naval-stores industry is to prosper, and an improved market for charcoal is a critical need of the hardwood distillation industry.

FOREST AND RANGE INFLUENCES

Influences research is under way at seven regional forest experiment stations. At four—California, Intermountain, Southwestern, and Appalachian—material progress has been made on primary installations in an intensive study of the effect of cover on water. The Southern Forest Experiment Station has just begun a similar study in the Ouachita National Forest. It promises to be an interesting development because of the high rainfall, steep slopes, and shallow soils which are responsible for an exceedingly rapid rate of run-off, and which cause the region to make a big contribution to flood waters of the lower Mississippi.

Floods.—The Ohio River flood of January 1937 points again to the need for similar studies in the Ohio Basin, especially at headwaters of the Allegheny River and on streams originating in the Cumberland Plateau and the Ozarks of southern Missouri.

Evidence accumulates on values of the forest as a protective cover in times of flood. Observations in southern Ohio of numerous pits, dug shortly after heavy January rains, show field soils at depths below 2 and 3 feet drier than surface soils. In contrast, forest soils up to 5 feet in depth contained as much or more water than did surface soils. This demonstrated again the greater absorptive capacity of forest soils.

Storm flow.—Storm flow from three small watersheds in western North Carolina illustrates the effect of misuse of land on run-off. Data for three summer and fall storms in 1936 show that, in percentages of precipitation, abandoned agricultural land has 2 to 10 times more storm flow than nearby forested land. Storm flow from eroded pasture land was from 3½ to 13 times as great as that from nearby forested land. Other data for 19 storms of approximately 2 inches showed maximum run-off from nonforest watersheds to be from 10 to 20 times greater than from forested ones.

Wind breaks.—Prairie States tree-planting investigations demonstrate that windbreaks reduce wind velocity by as much as 10 percent on the leeward side of the break for a distance of about 25 times the height of the trees. This reduction in velocity is especially valuable in protecting the region's highly erosible sandy soils. Windbreaks, especially those with conifers, also effect savings of 30 to 50 percent in the amount of fuel used in maintaining nearby favorable indoor winter temperatures. Indicators point to the wisdom of using narrow rather than wide windbreaks.

FOREST-MANAGEMENT INVESTIGATIONS

Successful management of forest resources plays an essential part in rural and industrial economy. This has focused attention on methods of handling forests. It has also accentuated the need for new and improved practices. Numerous investigations in regenerating forests, in protecting them from fire, and in tending and harvesting forest stands, contributed to this need.

Planting, timber-stand improvement, and fire-control practices developed and improved by research continued to provide the bases for large-scale employment of local and C. C. C. labor. Wider adoption of improved naval stores practices, aided by the naval stores conservation program under the amended Soil Conservation Act, served to further emphasize the value of naval stores research.

Planting and silvicultural.—Information on seed, nursery, and planting technique was made available to prairie States planting work. It was found, for example, that seedlings subjected to periodic dryness were more drought-resistant than those watered copiously and continuously, and that within limits the larger the seedlings the better the survival after planting in the field. It was also determined that high surface soil temperatures are often a cause of high mortality, and that the source of seed is directly related to the seedling's resistance to cold and drought. Subsoiling in preparing sites for planting increased survival. Methods of hastening germination of seeds involving both chemical and mechanical means were developed. Such studies aid materially in selecting drought-hardy and long-lived species, and in providing planting technique to insure better survival on farm wood-lot and shelterbelt planting.

A successful method was developed for long-leaf pine seed storage. In the nursery it was found that shading and root pruning in place under central-Louisiana conditions do not ordinarily improve field survival, that beds should be thinned to light uniform densities, and that low tree percentage is more likely traceable to the condition of the seed before sowing than to factors in the nursery. Planting studies showed that field survivals are markedly improved by not pruning roots to less than 6 inches, by setting seedlings at proper depths, by exercising care not to strip the rootlets or storing too long in heel-in beds or in water.

Advances were made in designing machinery and equipment to aid investigations and improve practices in seed and planting work. The Lake States station developed a new drought machine to test large numbers of plants under controlled conditions. This machine speeds up the process of selecting and developing drought-resistant plants suitable for prairie plains States. A machine for scarifying black locust seeds facilitates handling large quantities of seed now used extensively in planting for erosion control, and in farm wood lots for fence posts. The southern station designed simple devices for testing the maturity of southern pine cones based on specific gravity of the immersed cone.

Reforesting by direct sowing of seed instead of by planting nursery seedlings still holds promise in several important forest types. The necessity of protecting newly sown seeds and young seedlings from birds and rodents has been emphasized by studies in many sections of the country.

Studies of cutting methods to insure natural regeneration were continued. Western white pine trees of good vigor are essential if adequate seed is to be produced using methods depending upon clear cutting with seed trees. In the South it was learned that ground cover greatly affects the ability of the large-winged seed to reach the soil. This suggested removal of this barrier during the regenerating period. Light grass interferes least, oak litter next, and heavy pine litter most. Once seed has reached mineral soil, losses due to birds are affected in reverse order. Studies in the northeast spruce type reveal that stands easily regenerated depend for successful management mainly on protection for advance reproduction against logging damage, wind-throw, fire, and excessive shade and competition from hardwoods. Stands difficult to regenerate also require a light initial cut that removes one-fourth to one-half of the stand in order to permit reproduction. The remaining overstory should be removed after 10 to 15 years.

Selective types of cutting continued to be tested. It was found feasible in the redwoods to substitute selective-cutting methods (using tractors) for former heavy cuts where destructive slack-line yarding and heavy high-lead equipment were used. The best silvicultural practice for northern hardwoods involves partial cutting to remove about 30 percent of the stand. Success of light frequent cutting in ponderosa pine in the Northwest has been demonstrated on a large scale.

Forest genetics.—A comprehensive summary has been made of previous genetics studies. Ample evidence seems to have been accumulated to prove that seed from the locality in which it is to be planted is usually superior to that collected outside. Analysis of 20 years' test of Douglas fir plantations for which seedlings from known geographic seed sources were used showed differences in time of bud bursting, susceptibility to frost injury, and in height growth. All were in favor of the local seed. The same conclusion was drawn from tests of ponderosa pine in the northern Rocky Mountains, the Northwest, and in the

Rocky Mountain regions. In the latter region Douglas fir and lodgepole pine also showed similar results. Louisiana loblolly pine seed proved superior to Texas, Arkansas, and Georgia seed for plantations in Louisiana.

Another promising line of development is found in the new tree varieties that offer possibilities of superior pulping quality, more rapid growth, and increased resistance to disease, insects, drought, and low temperatures.

Fire, naval stores, and related investigations.—Research on forest-fire protection provided additional basis for improved fire-control technique, increased knowledge of the influence of various factors on fire behavior, and determined some important effects of fire on stand mortality, growth, reproduction, and soil conditions. In the work on fire control, improved methods for organization and detection planning were worked out for application by administrative agencies in California and the northern Rocky Mountains. Methods of fire-danger measurement continued to be improved by detailed studies of fuels and of individual factors affecting fire behavior. Substantial progress was made in integrating factors of fire behavior, fuel hazards, and visibility for improved fire-control planning.

Studies of soil on burned and unburned areas in the long-leaf pine belt yielded information on their chemical and physical properties. Burned-over soils are characterized by a slightly higher replaceable calcium content and a higher degree of compactness, and for the most part support an herbaceous vegetation in the typically open stands. In this connection it was determined that heat from forest fires in the longleaf pine type is ordinarily insufficient in itself to cause soil deterioration.

Naval stores studies gave several promising results. Preliminary tests indicated a 45-percent increase in gum yield of longleaf by the use of a 1-inch height of streak, followed by application of commercial hydrochloric acid to the freshened wound. Loss of gum from cups through rain washing was found to be negligible. Frequent dipping of cups did not conserve the turpentine content of the gum collected, but the practice may be desirable to prevent wastage from overfull or leaking equipment. Dry-facing following a severe fire is variable. In some cases it may require jump streaks of 1 to 12 inches when chipping is resumed.

For years there has been a feeling among naval stores men that the vigorous healing bars between faces were extra rich in resin. This belief has probably contributed greatly to mortality from excessive turpentining. Studies indicate that 4-inch bark bars between faces are desirable, and that gum yields from narrow faces placed on rapidly healing trees usually classed as worked-out ones were not much superior to those from faces of similar size on the usual back-faced tree.

A study of second-growth stands of loblolly, pure or mixed with hardwoods, by the Appalachian Forest Experiment Station contributed significant results in providing useful tables and in developing an improved method of predicting yield. The new method gives values which may be termed "empirical" as contrasted with the "theoretical" yields of normal tables attainable only with fully stocked stands. These new tables are more accurate than estimates derived by applying correction factors to normal tables. They can be applied by forest managers with a minimum of technical training.

As a byproduct of the work on yield of loblolly pine, additional light was shed on the relation of stand density to height growth of trees. It was found, for instance, that when density is expressed as a relation of number of trees per acre with average diameter, optimum height growth occurs within a comparatively narrow range of density. Also that both overstocking and understocking reduce heights attained for a given age and site quality. Since height growth has usually been considered solely a function of site quality, these results, by defining the extent to which it is affected by density, point the way toward more accurate appraisal of the productivity of forest areas. The more precise measurement of the influence of density on height, moreover, has value as a guide to thinning practices.

In view of the growing importance of partial cutting, the results of analysis of records covering 20 years' growth in selectively cut mixed conifer stands in California have more than local interest. One striking fact brought out is that the species falls into two groups, with significant differences between but not within the groups. Sugar pine and white fir grew at essentially the same rate, and faster than ponderosa pine, Douglas fir, and incense cedar. By taking into account factors of reserve volume per acre, site index, average volume per tree, percentage of volume in sugar pine and white fir, it is possible to estimate growth of selectively cut stands in the type within 10 percent of the actual mean on comparatively small areas. This degree of accuracy has not been possible heretofore. Closer control of cutting budgets through more accurate forecasts of growth is a major factor in sustained-yield operations.

RANGE RESEARCH

Study of range forage utilization standards, initiated in all western regions, aims to formulate practical "yardsticks" for describing approved grazing practices, and simple

usable methods of measuring utilization. Basic objectives are most efficient use of rangeland resources, including forage for livestock and wildlife; watershed protection; recreation; timber production; in short, permanent protection of human benefits dependent upon the range. Leading to a program of fundamental research to be conducted by the experiment stations, immediate efforts will concentrate on analysis of existing information with emphasis on national-forest ranges.

Range management.—Studies on semidesert ranges by the Southwestern station aim to maintain forage and livestock production under adverse conditions. After 20 years, the Jornada and Santa Rita experimental ranges in southern New Mexico and Arizona stack up with similar heavily stocked unregulated ranges of potentially equal productivity in part as follows: Grazing capacity on managed range is double that of outside range; net calf production is more than half again larger; death losses are two-thirds lower. Conservatively grazed ranges have maintained forage productivity better, and in some instances improved faster than ungrazed areas. Conservative grazing assures adequate range feed year after year, and minimizes supplemental feeding. Stocking the range 20 to 25 percent below average forage yield provides assurance against recurring drought and protects forage and livestock production. This is vital, since an abundance of cheap range forage is essential.

Similar studies by the Intermountain station show that if a range is stocked on the basis of average forage production or above, as often occurs, the stockman is in difficulty about half the years unless he offsets range-feed shortage with supplemental feed, which increases cost. On Utah mountain ranges, stocking approximately 20 percent below average forage production is found to be wise practice.

Forage values.—Studies of forage grazed on pine ranges by the California station show that early in the season the six species grazed most often, in order of importance, are sedge, hawkweed, mountain brome (*Bromus carinatus*), squirreltail grass, tarweed, and dandelion. But later in the season they were lupine, downy chess (*B. tectorum*), bitterweed, Idaho fescue, squirreltail grass, and sedge. Most surprising is the ranking of downy chess in second place late in the season. This was in spite of abundant other species commonly regarded as having better forage value. Average daily gain of fifteen 2-year-old steers ranged from 4.4 pounds the first 2 weeks of the grazing season, beginning in mid June, to 1.9 pounds for the period ended August 15. Total average gain for the season was 189 pounds. This average rate of nearly 2 pounds per day was a surprisingly high value for cut-over-pine cattle ranges.

Reseeding.—Artificial reseeding tests in central Utah foothills by the Intermountain station showed that smooth brome, after 5 years, increased the grazing capacity ninefold. Native mountain brome and crested wheatgrass increased the capacity three to four times. At higher elevations, mountain and smooth bromes and the native slender wheatgrass proved successful whereas crested wheatgrass failed.

In seeking restoration of millions of acres of abandoned farms in the northern Great Plains, encouraging reseeding results in spite of drought have been obtained by the northern Rocky Mountain station. Crested wheatgrass holds promise for eastern Montana. Best and most consistent results were obtained from fall as against spring seeding.

In transplanting experiments on southern New Mexico semidesert ranges, the Southwestern station attained a 50-percent survival of 1935 transplants of black grama, mesa dropseed, paspalum, and four-wing saltbush or chamiza. Where protected from rodents and cattle it is estimated that fully 90 percent of the 1935 transplants are surviving. This increase is due chiefly to improvements in planting technique. Chamiza seeds germinated best when they were barely covered, but paspalum seeds responded best when covered from 1 to 2 inches deep. Paspalum seeds usually germinated from July to September, a period when water was available and soil temperatures were high. Chamiza seeds, in contrast, rarely germinated until late September or October, when ground surfaces had cooled. These results indicate the kind of practical information that must be determined for successful reseeding.

Added studies.—A survey of range conditions and problems by the Rocky Mountain station indicated the urgent need for studies of management of the short-grass plains in eastern Colorado and Wyoming. Accordingly an experimental range was established in Weld County, Colo., in cooperation with the former Resettlement Administration.

During the year range investigations were started by the newly organized field division of range research at the Pacific Northwest station, which serves Oregon and Washington.

FOREST PRODUCTS

Forest-products research, the bulk of which is conducted at the Forest Products Laboratory at Madison, Wis., is concerned with (1) reducing wastes and lowering costs of harvesting, converting, and utilizing the timber crop; (2) insuring to the consumer better service from wood in natural and converted forms; and (3) developing for wood new uses, and through them new social and economic values.

All this is essential in progress toward permanent, prosperous forest communities and productive use of forest lands generally. It is of direct interest to the producer, processor, and the consumer. The farmer has a vital stake in forest-products research for he is, at one and the same time, producer, processor, and consumer. He is also the largest per capita consumer of forest products in the United States and owns, in farm wood lots, more than one-fourth of the Nation's forest land.

Pulp and paper.—This farm ownership is an important factor in the pulp and paper industry, particularly in the South. Pulp and paper investigations have for several years past been directed toward improved utilization of southern and western species. This is because of the immense quantities of potential material available from these woods, and the desirability of more effective use of them. The significance of this program has been made apparent by the recent tremendous growth of the industry, particularly in the South, the resultant interest in the properties of the woods available for pulp, and in methods of handling and converting pulp.

Progress was made during the year in studies of the influence of growth conditions upon the quality of southern pine pulpwood, and previous indications that these conditions are more significant than any differences in species were verified. Studies of the production of newsprint from southern pines also yielded data of interest. The previously suggested method of substituting semibleached sulphate pulp for the sulphite normally used in newsprint was improved. Advances made in methods of handling pine furnish on the paper machine resulted in laboratory-made newsprint papers of the highest quality.

Pulping quality of both Douglas fir and western hemlock was found to be affected by growth conditions. The range of variation was not so marked as in the southern pines, and did not present the problems in operation that were encountered with them. Study of the paper-making properties of Douglas fir pulps, with particular reference to book and mimeograph papers, resulted in methods for securing the opacity, bulk, and ink-absorption properties which were normally lacking in papers made from extremely long-fibered woods.

A systematic investigation of soda-base sulphite pulping was continued. This included use of neutral monosulphite liquors combined with various buffers. Extremely strong, bleachable pulps having excellent possibilities for the manufacture of high-grade strong papers were produced from a wide range of species. In fundamental work on the sulphate and soda processes, the influence of sulphur added to the cooking liquors showed that improvements in yield and strength are marked only in cases where the softwoods are used. Comparison of the mechanical pulping of well-seasoned spruce and aspen showed that the latter, although apparently a softer wood, when ground to the same freeness requires a power consumption 1.5 times that required for spruce.

Chemical composition and utilization of wood.—Chemical conversion of cull and low-grade trees and logging and milling wastes into useful products offers a great potential possibility of economic significance to all timberland owners. During the year plastics formed by the hydrolysis of sawdust were further improved, and were found to afford practical binders for veneer, paper, and other coatings. A new wood plastic was prepared by direct acetylation of wood.

Lignin, the second-largest constituent of wood, was shown by X-ray to be crystalline instead of amorphous, as was previously supposed. The amount of lignin that may be removed from wood by treatment with organic and inorganic solutions was determined. This information establishes one more milestone in the progress toward a better understanding of the chemical composition of wood.

Time required for isolation of holocellulose, the subdivision of wood containing fibrous and sugarlike constituents, was reduced from 2 days to less than 3 hours. This made it a practical analytical method. Rate of leaching of the water-soluble preservative sodium fluoride from wood was shown to be appreciably reduced by the presence of slow-leaching chromates.

Growth, harvesting, and utilization.—With a constantly increasing proportion of second growth in our forests, the problem of improving the quality of timber deserves the consideration given to it. Investigation showed that in pure stands and plantations several more important commercial softwoods will yield only low-grade lumber in rotations of 60 to 80 years, even when fully stocked. A manuscript was prepared on the effect of knots on lumber quality, and on the desirability of artificial pruning to obtain maximum amount of clear wood in the shortest time. Specific-gravity determinations indicated that second-growth oak from the Appalachian Mountain region is not so soft textured as old-growth material. This is due primarily to a more thrifty growth of the second-growth trees. Lumber cut from second-growth southern pine which had made rapid initial growth followed by slower growth later on, was found to warp excessively when both types of wood occurred in the same board. This is accounted for by the unusually high longitudinal shrinkage of wood containing wider growth rings. It can be controlled to some extent by carrying out forest and wood-lot thinnings that will maintain trees at a relatively constant rate of growth.

Studies of diameter limit below which it is unprofitable for farmers and other timber owners to cut trees for sale were completed on second-growth northern white pine and

hardwoods in New England. A study in Southeastern States revealed that cutting trees smaller than 8 inches in diameter for pulpwood is unprofitable, and results in skinning the land. Assistance was given in planning utilization units for the cooperative timber harvesting and marketing project at Cooperstown, N. Y., and for the project of the former Resettlement Administration near Elkins, W. Va. Logging and milling studies were made in Lake and South Atlantic States to provide information needed in the forest survey and in appraisal and acquisition programs of the Forest Service.

New kiln schedules, that make practicable the drying of black gum and other refractory hardwoods green from the saw, were devised. They should aid forest landowners in establishing outlets for many species of wood heretofore considered unprofitable because of seasoning difficulties, and should also aid consumers by reducing freight charges and eliminating rehandling and redrying charges. Progress was made in seasoning large items of Douglas fir and other refractory species with chemicals. Invert sugar, a nonconductor of electricity, continued to give satisfactory results in seasoning cross arms. Blackstrap molasses selling at $20 a ton was found to be a possible substitute for pure invert sugar selling at 5 cents a pound.

Two additional seed-cone kilns of Forest Products Laboratory design were installed—one on the Chippewa and one on the Manistee National Forest. Proper temperatures and relative humidities for kiln drying northern white pine and jack pine cones in these kilns, with a maximum yield of viable seed, were determined experimentally.

Attention was given to developing less complex methods for treating fence posts and other farm timber with wood preservatives. Good penetration was obtained in lumber and peeled posts by soaking the wood for 2 weeks in a 10-percent solution of zinc chloride or other water-soluble preservative. The greener the material the better the penetration. Complete sapwood treatment was obtained in freshly cut round posts, with the bark on, by allowing zinc chloride solution held in a section of an old automobile inner tube to penetrate, under force of gravity, the end grain of the posts. Although zinc chloride treatment is not so effective as impregnation with creosote, it should make posts of nondurable wood as decay-resistant as most untreated naturally durable posts. The method is inexpensive and generally suitable for water-borne preservatives.

Improved wood construction.—Research was continued on wood as a material for construction of better homes for more people at prices they can afford to pay. Emphasis was placed on low-cost construction, insulation, and fireproofing. Development of a system of prefabricated house construction with plywood-covered wall, floor, and roof units culminated in plans and contracts for the erection of two such houses on the laboratory grounds. Detailed cost data to be kept during fabrication and erection will demonstrate possibilities of this all-wood construction system as a means of providing low-cost housing.

Promising possibilities were also indicated in use of wood in the form of lumber for prefabricated house units. Information was obtained, in fire tests of plywood-faced wall panels, on resistance to fire spread and fire penetration. Plywood glued with phenol-resin glue proved more fireproof and moisture-resistant than plywood glued with less water-resistant glues.

Progress was also made in solving problems arising from modern building methods that cause condensation in walls and attics during cold weather. Vapor barriers of roll or building-paper type were found a practical and economical method of control. Antishrinkage treatments with synthetic resins formed in wood were developed for plywood. These methods increase resistance to passage of moisture, reduce weather checking, and make a smoother and more attractive surface.

Survey was made of good and bad practices in small-house construction. From it a bulletin for prospective home buyers and builders will be prepared. In representative cities in 17 widely separated States, only a few small houses in the $3,000 to $6,000 class were found to be consistently poor throughout, although some bad structural features and some newly developed good features were encountered. These should be more widely recognized in current building activities.

Work was begun during the year on a bulletin showing the design, suitability, and economy of laminated or glued-up arches for use in buildings requiring large clear spans. Barn rafters of this construction promise to be cheaper as well as better than types now employed. American-made metal connectors for large structural timbers were found to be equal or superior to foreign-made connectors of the same type.

Painting.—Studies in painting of wood have continued. The main objective is to make satisfactory results in house painting more certain, and reduce painting costs to home owners and farmers. Because of the great number and variety of house paints, frequent introduction of new formulas, and the lack of any system of classification or grading, it is exceedingly difficult to give specific directions for obtaining best painting results. So consumers can be reliably informed, it seems necessary that a practical system of separating paints into classes and types be developed and put into practice. Tentative system of this kind has been devised by the laboratory. It is offered as a first step in the difficult task of bringing order out of present chaotic conditions.

Related investigations.—In addition to leading projects already summarized, certain lesser ones deserve brief mention.

Experiments were conducted on fire-extinguishing effectiveness of more than 200 chemical solutions for use in fighting forest fires. Many solutions showed some superiority over water in direct extinction, and considerable superiority in an indirect attack which pretreats a strip in advance of the fire to act as a line from which to backfire.

An inspection of the 1937 Ohio River flood area confirmed the belief that structural damage to frame buildings by floods can in large measure be prevented by securely anchoring buildings to firm foundations with bolts.

Survey was made of the effect on the employment of labor of recent changes in methods and equipment used in the lumber industry. End result for the lumber industry east of the Rocky Mountains was a slight decrease during the past decade in man-hour requirements per 1,000 board feet of lumber manufactured.

Assistance was rendered the Post Office Department in the identification of wood, glue, and paper retrieved from fatal bombs sent through the mails.

In addition to publications already mentioned, manuscripts were prepared on production of pulpwood in the mid-Atlantic region, design and behavior of lag screws, how the farmer and consumer can use the Forest Products Laboratory, chemical products from forest trees, and the amateur woodworkers' handbook. To help keep the farmer abreast the many forest-products investigations of direct benefit to him, an extensive series of articles was released for publication in State and local farm papers.

New Legislation Affecting the Forest Service

The following Federal legislation affecting the Forest Service was enacted at the first session, Seventy-fifth Congress. For convenience, this record indicates acts passed after as well as before close of the fiscal year.

Appropriation Acts

First deficiency.—Act of February 9, 1937 (Public, No. 4) includes: (1) $2,045,000 for emergency fire fighting, fiscal year 1937; (2) $789,000,000 for relief work to June 30, 1937 (total to Forest Service under this and previous similar acts for fiscal year 1937 was $17,541,349); (3) $95,000,000, Emergency Conservation Work to June 30, 1937.

Department of Agriculture.—The act of June 29, 1937 (Public, No. 173), making regular appropriations for fiscal year 1938.

Emergency relief.—Act of June 29, 1937 (Public, No. 47), carrying $1,500,000,000 for fiscal year 1938, with $4,479,010 project funds and $175,000 administrative funds (total $4,654,010), for the Forest Service for July to December 1937, inclusive.

Civilian Conservation Corps.—Act of July 1, 1937 (Public, No. 50), appropriating $350,000,000 for fiscal year 1938.

Other Acts

Act of May 28, 1937 (Public, No. 95), authorizing cooperation in developing farm forestry in States and Territories, and an annual appropriation not to exceed $2,500,000 for carrying out the Cooperative Farm Forestry Act. No appropriation was made by the first session of the Seventy-fifth Congress.

Act of July 9, 1937 (Public, No. 195), providing for acquiring certain lands—part of which are within the Stanislaus National Forest—and adding them to Yosemite National Park, Calif.

Act of July 27, 1937 (Public, No. 214), providing for adding certain lands to the Rogue River National Forest, Oreg.

Act of August 12, 1937 (Public, No. 257), authorizing adding certain lands in Washington to the Columbia National Forest.

Act of August 21, 1937 (Public, No. 333), authorizing revision of boundaries, Snoqualmie National Forest, Wash., and adding certain lands thereto.

Act of June 28, 1937 (Public, No. 163), establishing the Civilian Conservation Corps for a period of 3 years and providing employment and vocational training for youthful citizens of the United States who are unemployed and in need of employment on works of public interest or utility for the protection, restoration, development, etc., of natural resources of forest and other lands and waters, and the products thereof.

Appendix

TABLE 1.—*National-forest additions and eliminations, fiscal year 1937*

National forest	State	Additions	Eliminations	National forest	State	Additions	Eliminations
		Acres	*Acres*			*Acres*	*Acres*
Angelina	Texas	[1] 388,700		Ocala	Florida	[1] 178,944	
Bitterroot	Montana	[2] 2,271		Ottawa	Michigan	11,490,069	
Do	do	[3] 11,289		Ouachita	Arkansas	[1] 544,910	
Black Hills	So. Dakota	[3] 398		Pisgah	N. Carolina	[1] 718,646	
Cabinet	Montana	[3] 1,072		Plumas	California	[3] 9,196	
Carson	N. Mexico	[4] 1		Roosevelt	Colorado	[4] 5	
Chattahoochee	Georgia	[1] 503,300		Sabine	Texas	[1] 439,600	
Chequamegon	Wisconsin	[1] 227,684		Sam Houston	do	[1] 491,800	
Cherokee	Tennessee	[1] 338,900		Santa Fe	N. Mexico	[4] 228	
Chippewa	Minnesota	[1] 1,000,263		Shasta	California	[3] 640	
Do	do	[4] 4		Sitgreaves	Arizona		[1] 3
Coconino	Arizona		[1] 360	Snoqualmie	Washington	[2] 200	
Conecuh	Alabama	[1] 339,573		St. Joe	Idaho	[3] 240	
Croatan	N. Carolina	[1] 306,300		Sumter	S. Carolina	[1] 831,000	
Cumberland	Kentucky	[1] 1,338,214		Superior	Minnesota	[1] 1,215,616	
Davy Crockett	Texas	[1] 394,200		Tahoe	California	[3] 1,938	
Deschutes	Oregon	[3] 601		Do	do	[4] 3,524	
Eldorado	California	[4] 6,735		Talladega	Alabama	[1] 721,365	
Francis Marion	S. Carolina	[1] 414,700		Tongass	Alaska		[1] 65
Green Mountain	Vermont	[1] 478,420		Do	do	[1] 3,800	
Harney	S. Dakota	[3] 558		Tonto	Arizona		[1] 480
Do	Wyoming	[3] 1,641		Uinta	Utah	[1] 1,360	
Hiawatha	Michigan	[1] 11,200		Umatilla	Oregon	[3] 17,388	
Homochitto	Mississippi	[1] 373,460		Wichita	Oklahoma		[1] 61,640
Kaniksu	Idaho	[2] 28,286					
Kootenai	Montana	[3] 7,767		Sub-total		14,104,529	62,548
Lolo	do	[3] 9,747		Adjustment		[5] 44,668	
Nantahala	N. Carolina	[1] 664,427					
Nicolet	Wisconsin	[1] 584,349		Total		14,149,197	62,548

[1] Made by Presidential proclamation, Executive order, or Administrative order.
[2] Made by donation of private lands.
[3] Private lands acquired through exchange.
[4] Private lands acquired by purchase.
[5] Net increase through recomputations of areas, based on new survey data.

TABLE 2.—*Classification of mileage in forest-road and trail system, and expenditure required to complete the system to a satisfactory standard, June 30, 1937*

Class	Total	Satisfactory standard	Unsatisfactory standard	Nonexisting	Expenditure required to complete
	Miles	*Miles*	*Miles*	*Miles*	*Dollars*
Forest highways	23,147	12,654	9,264	1,229	289,382,800
Forest-development roads	113,307	47,654	32,914	32,739	117,397,600
Total	136,454	60,308	42,178	33,968	406,780,400
Trails	155,815	121,229	17,267	17,319	4,859,100
Total					411,639,500

TABLE 3.—*Construction, improvement, and maintenance of national-forest roads and trails from forest-road appropriations and other Federal and cooperative funds, by States, June 30, 1937*

State	Fiscal year 1937				Total constructed to June 30, 1937		Expenditures to June 30, 1937		
	Constructed		Maintained						
	Roads	Trails	Roads	Trails	Roads	Trails	Federal funds [1]	Cooperative funds	Total funds
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Dollars*	*Dollars*	*Dollars*
Ala	250.0	-------	223.1	---------	417.5	---------	1,840,884.80	25,278.16	1,866,162.96
Alaska	15.3	40.9	275.3	223.5	306.3	906.9	9,642,230.41	329,262.27	9,971,492.68
Ariz	119.8	83.0	4,480.4	2,791.0	3,637.0	2,371.6	16,491,400.25	1,223,012.79	17,714,413.04
Ark	101.3	-------	2,205.1	754.7	1,785.5	571.4	7,889,721.57	136,491.86	8,026,213.43
Calif	366.2	34.8	14,670.9	14,731.7	10,783.6	12,375.3	56,738,779.64	9,217,367.26	65,956,146.90
Colo	77.0	112.9	1,362.5	11,295.8	2,079.6	12,338.7	15,565,813.59	1,222,352.35	16,788,165.94
Fla	92.0	-------	1,014.0	---------	1,466.2	---------	2,771,854.50	161,728.19	2,933,582.69
Ga	40.3	-------	432.8	170.3	521.3	362.1	3,997,441.00	137,533.21	4,134,974.21
Idaho	401.1	227.7	6,728.2	25,310.5	6,658.0	21,606.8	41,199,757.90	1,954,079.98	43,153,837.88
Ill	42.8	-------	233.4	---------	275.6	---------	1,947,875.09	184.28	1,948,059.37
Ind	4.1	-------	2.3	---------	6.4	---------	114,077.95	----------	114,077.95
Kans	-------	-------	---------	---------	3.4	---------	2,111.51	----------	2,111.51
Ky	32.5	-------	114.8	---------	172.8	---------	2,165,750.51	----------	2,165,750.51
La	39.0	-------	122.6	---------	161.1	---------	937,438.55	----------	937,438.55
Maine	-------	-------	13.6	90.0	14.0	90.0	465,997.72	----------	465,997.72
Md	-------	-------	---------	---------	---------	---------	70.05	----------	70.05
Mich	271.3	-------	2,077.0	---------	2,638.2	---------	3,886,860.90	263,805.07	4,150,665.97
Minn	100.2	66.0	922.6	303.0	1,205.2	963.3	3,706,769.99	333,786.75	4,040,556.74
Miss	191.8	-------	667.3	---------	838.2	---------	3,868,047.21	2,256.58	3,870,303.79
Mo	173.5	-------	794.1	---------	763.0	---------	2,688,665.39	----------	2,688,665.39
Mont	139.2	174.0	3,831.2	22,834.0	2,561.3	19,967.3	21,349,075.47	672,314.12	22,021,389.59
Nebr	-------	-------	142.7	---------	116.7	---------	272,664.14	990.80	273,654.94
Nev	27.8	1.5	610.8	1,699.8	736.4	944.7	3,714,696.70	179,424.04	3,894,120.74
N. H	19.7	24.8	122.3	1,036.6	139.7	914.9	2,861,201.87	95,949.70	2,957,151.57
N. J	-------	-------	---------	---------	---------	---------	217.71	----------	217.71
N. Mex	97.8	31.4	2,581.1	3,279.0	2,449.3	1,804.5	12,149,386.62	337,089.91	12,486,476.53
N. Y	-------	-------	---------	---------	---------	---------	81.32	----------	81.32
N. C	90.6	30.1	522.4	878.7	663.4	774.5	6,392,995.42	478,528.91	6,871,524.33
N. Dak	-------	-------	.5	---------	1.0	---------	159.85	----------	159.85
Ohio	10.9	-------	---------	---------	19.4	---------	249,475.72	----------	249,475.72
Okla	13.3	-------	167.8	1.5	162.2	16.5	860,833.08	17,065.09	877,898.17
Oreg	130.7	68.4	10,655.6	15,546.0	7,160.9	9,963.1	34,689,464.80	8,573,590.65	43,263,055.45
Pa	15.3	-------	248.3	277.8	239.4	277.8	3,005,902.01	42,234.91	3,048,136.92
P. R	19.3	2.0	11.5	17.0	30.8	63.6	1,816,925.02	550.00	1,817,475.02
S. C	94.6	-------	351.9	18.2	357.2	18.2	1,988,725.51	15,659.81	2,004,385.32
S. Dak	16.9	-------	105.5	8.0	503.8	108.1	2,290,782.60	241,605.27	2,532,387.87
Tenn	50.9	20.0	503.5	570.4	555.5	748.0	4,403,941.34	197,596.61	4,601,537.95
Tex	137.9	-------	395.0	---------	395.0	---------	1,825,811.34	----------	1,825,811.34
Utah	73.3	100.2	2,207.1	5,690.8	2,372.5	4,186.7	10,244,242.24	1,048,158.38	11,292,400.62
Vt	4.8	.2	50.1	194.5	16.0	20.7	765,031.23	----------	765,021.23
Va	35.1	195.9	658.5	996.4	469.4	1,192.3	4,406,367.41	109,614.95	4,515,982.36
Wash	132.6	113.0	2,936.0	14,083.7	3,408.5	10,098.5	23,224,761.38	1,742,062.51	24,966,823.89
W. Va	47.9	36.8	462.2	795.2	522.0	799.0	3,692,029.64	38,159.30	3,730,188.94
Wis	235.0	-------	1,346.9	---------	1,510.1	---------	2,788,263.59	2,131.55	2,790,395.14
Wyo	35.8	40.0	1,106.7	6,246.1	1,425.1	2,763.9	9,829,336.69	407,596.51	10,236,933.20
Total	3,747.6	1,403.6	65,357.6	129,844.2	59,548.5	106,248.4	328,743,921.23	29,207,461.77	357,951,383.00

[1] Includes exact figures for road funds and approximate figures for C. C. C., equipment rentals, and other Government funds for the current fiscal year.

TABLE 4.—*Distribution among the States of the road and trail apportionments for the fiscal year 1938*

State	10 percent fund roads and trails for States, national-forest funds	Forest highways	Forest-road development	Total
Alabama	$77.12	$31,250.00	$15,185.00	$46,512.12
Alaska	6,029.39	350,000.00	30,570.00	386,599.39
Arizona	28,022.10	547,212.00	226,324.00	801,558.10
Arkansas	26,691.07	111,905.00	46,225.00	184,821.07
California	71,540.83	1,334,121.00	763,426.00	2,169,087.83
Colorado	51,848.39	686,502.00	226,370.00	964,720.39
Florida	9,910.42	82,636.00	18,987.00	111,533.42
Georgia	743.83	44,605.00	28,190.00	73,538.83
Idaho	45,503.84	963,408.00	723,776.00	1,732,687.84
Illinois	132.84	14,694.00	37,671.00	52,497.84
Indiana	22.29	3,703.00		3,725.29
Kentucky	138.36	26,293.00	46,772.00	73,203.36
Louisiana	736.81	32,142.00	3,818.00	36,696.81
Maine	257.49	5,641.00	2,535.00	8,433.49
Michigan	3,100.84	117,552.00	110,690.00	231,342.84
Minnesota	4,059.81	112,167.00	58,274.00	174,500.81
Mississippi	1,434.51	68,688.00	39,216.00	109,338.51
Missouri	411.30	60,083.00	70,568.00	131,062.30
Montana	22,257.05	753,310.00	475,906.00	1,251,473.05
Nebraska	1,072.05	15,383.00	1,663.00	18,118.05
Nevada	8,288.35	171,272.00	47,352.00	226,912.35
New Hampshire	4,153.86	86,729.00	21,376.00	112,258.86
New Mexico	15,241.82	383,786.00	148,622.00	547,649.82
North Carolina	3,975.53	84,048.00	60,867.00	148,890.53
North Dakota	.50			.50
Ohio	25.55	3,527.00	125.00	3,677.55
Oklahoma	1,391.34	9,154.00	2,716.00	13,261.34
Oregon	63,783.08	1,254,717.00	495,984.00	1,814,484.08
Pennsylvania	1,623.87	40,116.00	30,361.00	72,100.87
Puerto Rico	56.20	3,050.00	2,657.00	5,763.20
South Carolina	3,122.45	45,926.00	45,045.00	94,093.45
South Dakota	9,806.21	125,787.00	20,667.00	156,260.21
Tennessee	2,633.68	49,236.00	31,603.00	83,472.68
Texas	2,837.86	49,674.00	35,323.00	87,834.86
Utah	14,658.27	313,486.00	163,717.00	491,861.27
Vermont	992.92	21,334.00	14,190.00	36,516.92
Virginia	2,645.75	89,317.00	53,415.00	145,377.75
Washington	51,677.90	684,890.00	321,562.00	1,058,129.90
West Virginia	463.81	62,644.00	54,398.00	117,505.81
Wisconsin	754.73	79,208.00	49,613.00	129,575.73
Wyoming	23,694.78	414,137.00	140,908.00	578,739.78
Total	485,818.80	9,333,333.00	4,666,667.00	14,485,818.80

TABLE 5.—*Distribution among the States of the total road and trail apportionments including the fiscal year 1938*

State	10 percent fund roads and trails for States, national-forest funds	Sec. 8 cooperative construction, etc., of roads and trails, national forests	Federal forest-road construction	Forest highways [1]	Forest-road development [2]	Improvement [3]	Total
Alabama	$1,134.43	$15,456.04	$1,922.31	$130,425	$173,982	$31,077.06	$353,996.84
Alaska	193,707.27	470,963.60	203,229.50	8,985,549	394,461		10,247,910.37
Arizona	781,356.92	677,956.45	490,434.11	7,579,041	2,646,549	546,273.39	12,721,610.87
Arkansas	225,586.29	175,126.19	128,423.38	1,206,017	1,054,526	295,897.47	3,085,576.33
California	1,967,172.23	1,464,333.82	1,201,431.20	18,297,141	9,582,533	1,518,217.76	34,030,829.01
Colorado	979,051.16	770,948.34	784,259.55	9,090,518	2,865,277	197,297.57	14,687,351.62
Florida	70,240.51	119,528.14	21,534.94	475,808	269,982	140,417.47	1,097,511.06
Georgia	17,534.63	52,393.57	130,443.73	289,014	381,328	133,229.53	1,003,943.46
Idaho	1,174,382.84	1,176,750.85	1,337,004.17	13,435,245	10,904,630	1,827,886.55	29,855,899.41
Illinois	178.77			47,012	73,907		121,097.77

[1] Includes emergency funds for highways under acts of June 19, 1934, and June 16, 1933.
[2] Includes emergency funds for development roads under acts of June 19, 1934, and June 16, 1933.
[3] Includes emergency improvement funds under act of July 21, 1932.

TABLE 5.—*Distribution among the States of the total road and trail apportionments, including the fiscal year 1938*—Continued

State	10 percent fund roads and trails for States, national-forest funds	Sec. 8 cooperative construction, etc., of roads and trails, national forests	Federal forest-road construction	Forest highways	Forest-road development	Improvement	Total
Indiana	22.29			5,350			5,372.29
Kansas	1,867.27						1,867.27
Kentucky	1,014.67			71,254	199,372		271,640.67
Louisiana	1,100.60			98,750	87,425	38,132.47	225,408.07
Maine	4,812.10	32.41	3,738.77	40,586	42,650	21,909.56	113,728.84
Maryland	70.05						70.05
Michigan	10,398.75	115.63	3,000.00	436,589	681,656	164,507.86	1,296,267.24
Minnesota	54,006.54	8,036.36	108,352.03	1,000,874	718,029	130,348.59	2,019,646.52
Mississippi	2,013.52			181,576	176,151	8,598.45	368,338.97
Missouri	514.79			134,369	153,471		288,354.79
Montana	703,048.90	762,523.77	764,035.26	10,609,484	5,389,481	651,377.24	18,879,950.17
Nebraska	23,892.54	18.98		134,131	66,424	578.27	225,044.79
Nevada	218,687.64	192,989.88	81,491.85	2,474,473	278,576	45,878.18	3,292,096.55
New Hampshire	66,495.02	7,165.35	10,941.30	614,307	305,523	56,487.05	1,060,918.72
New Jersey	118.99				83		201.99
New Mexico	416,307.46	426,086.04	518,426.97	5,445,884	2,068,977	408,824.28	9,284,505.75
New York	4.00				20		24.00
North Carolina	54,336.54	86,336.41	176,466.28	476,973	812,542	192,530.92	1,799,185.15
North Dakota	46.25	7.00			125		178.25
Ohio	25.55			5,068			5,093.55
Oklahoma	16,750.09	65.49	2,775.17	86,807	196,815	35,700.19	338,912.94
Oregon	1,213,697.74	1,428,785.95	1,013,981.59	16,636,981	7,893,818	876,916.07	29,064,180.35
Pennsylvania	11,327.44	7,724.04	21.42	235,398	294,405	79,976.40	628,852.30
Puerto Rico	294.39	7.00	3,343.09	17,985	32,681	4,714.52	59,025.00
South Carolina	7,336.59	402.10	48,028.61	132,298	142,390	171.08	330,626.38
South Dakota	226,636.08	87,106.45	78,652.52	1,061,729	411,397	33,879.18	1,899,400.23
Tennessee	27,309.81	106,854.56	27,967.79	362,328	444,327	100,304.31	1,069,091.47
Texas	2,982.69			107,431	55,067		165,480.69
Utah	499,544.80	464,918.34	512,489.56	4,440,678	1,378,046	183,090.76	7,478,767.46
Vermont	2,624.46			53,402	79,736	10,778.15	146,540.61
Virginia	54,945.61	58,390.16	71,784.26	507,514	581,036	154,268.85	1,427,938.88
Washington	874,082.09	958,090.33	732,302.49	9,201,080	5,652,574	862,891.32	18,281,020.23
West Virginia	7,762.52	12,830.41	5,049.24	280,692	471,511	208,604.94	986,450.11
Wisconsin	1,630.43			253,654	389,765	98,415.88	743,465.31
Wyoming	561,389.62	468,056.34	538,468.91	5,789,918	1,915,419	102,815.87	9,376,067.74
Total	10,477,442.88	10,000,000.00	9,000,000.00	120,433,333	59,266,667	9,161,997.19	218,339,440.07

TABLE 6.—*Condition of forest-road funds on June 30, 1937*

Fund	Appropriations	Expenditures	Balance
10-percent	$9,991,624.08	$9,467,173.61	$524,450.47
Section 8	10,000,000.00	10,000,000.00	
Federal forest-road construction	9,000,000.00	9,000,000.00	
Forest highways	76,600,000.00	76,495,665.51	104,334.49
Forest highway emergency construction	7,000,000.00	6,809,703.73	190,296.27
Emergency forest highways	8,000,000.00	7,997,245.18	(1)
Forest highways, N. R. A	14,600,000.00	14,556,381.39	43,618.61
Forest-road development	40,900,000.00	39,789,722.01	1,110,277.99
Forest-road development emergency construction	3,000,000.00	2,991,797.42	8,202.58
Forest-road development, N. R. A	10,100,000.00	10,099,627.12	[2] 290.72
Improvement	9,161,997.19	9,161,997.19	
Total	198,353,621.27	196,369,313.16	1,981,471.13

[1] $2,754.82 returned to the Treasury.
[2] $84.66 returned to P. W. A.; $2.50 adjustment.

TABLE 7.—*Comparison of fires on national forests, calendar years 1936, 1935, and 5-year average, 1932–36*

Item	Number of fires			Percentage of totals		
	1936	1935	Average 1932–36	1936	1935	Average 1932–36
Class:						
Burns of 0.25 acre or less	7,026	5,946	5,354	41.75	55.63	51.74
Burns of between 0.25 and 10 acres	6,362	3,078	3,233	37.81	28.79	31.24
Burns of 10 acres and over	3,439	1,665	1,761	20.44	15.58	17.02
Total	16,827	10,689	10,348	100.00	100.00	100.00
Cause:						
Railroads	402	225	210	2.39	2.11	2.03
Lightning	5,163	4,031	3,793	30.68	37.71	36.65
Incendiarism	2,594	1,389	1,415	15.42	12.99	13.67
Debris burning	2,851	775	953	16.94	7.25	9.21
Lumbering	285	267	161	1.69	2.50	1.56
Campfires	1,076	920	887	6.40	8.61	8.57
Smokers	3,457	2,545	2,391	20.54	23.81	23.11
Miscellaneous	999	537	538	5.94	5.02	5.20
Total	16,827	10,689	10,348	100.00	100.00	100.00

Calendar year	Total area of national-forest land burned over	Total damage of national-forest land burned over	Total cost of fighting fires exclusive of time of forest officers
	Acres	*Dollars*	*Dollars*
1936	280,554	1,220,187	[1] 2,689,660
1935	168,394	336,145	[2] 1,325,979
5-year average 1932–36	301,875	833,961	1,824,788

[1] Of this amount $1,074,723 was Emergency Conservation Work and Emergency Relief Administration funds.
[2] Of this amount $544,213 was Emergency Conservation Work and Emergency Relief Administration funds.

TABLE 8.—*Quantity and value of national-forest timber cut under sales, fiscal year 1937*

State	Quantity cut			Value		
	Commercial sales	Cost sales	Total	Commercial sales	Cost sales	Total
	Board feet	*Board feet*	*Board feet*	*Dollars*	*Dollars*	*Dollars*
Alabama	102,000		102,000	477		477
Alaska	42,508,000		42,508,000	64,056		64,056
Arizona	60,801,000	430,000	61,231,000	139,436	449	139,885
Arkansas	18,444,000	311,000	18,755,000	226,527	315	226,842
California	174,734,000	1,691,000	176,425,000	358,574	1,344	359,918
Colorado	58,717,000	675,000	59,392,000	143,187	660	143,847
Florida	14,752,000		14,752,000	82,848		82,848
Georgia	1,719,000		1,719,000	7,598		7,598
Idaho	77,435,000	4,947,000	82,382,000	241,266	4,636	245,902
Illinois	38,000		38,000	271		271
Indiana	4,000		4,000	57		57
Kentucky	520,000		520,000	1,357		1,357
Louisiana	767,000		767,000	966		966
Maine	575,000		575,000	1,686		1,686
Michigan	12,240,000	2,000	12,242,000	23,839	3	23,842
Minnesota	12,739,000	30,000	12,769,000	27,054	20	27,074
Mississippi	11,721,000		11,721,000	12,639		12,639
Missouri	460,000	3,000	463,000	1,901	4	1,905
Montana	37,772,000	3,278,000	41,050,000	82,415	3,216	85,631
Nebraska	13,000		13,000	25		25
Nevada	635,000	165,000	800,000	574	131	705
New Hampshire	12,791,000		12,791,000	41,565		41,565
New Mexico	16,608,000	1,089,000	17,697,000	35,518	1,110	36,628
North Carolina	25,324,000		25,324,000	46,300		46,300
Ohio	16,000		16,000	68		68

TABLE 8.—*Quantity and value of national-forest timber cut under sales, fiscal year 1937*—Continued

State	Quantity cut			Value		
	Commercial sales	Cost sales	Total	Commercial sales	Cost sales	Total
	Board feet	*Board feet*	*Board feet*	*Dollars*	*Dollars*	*Dollars*
Oregon	212, 439, 000	3, 823, 000	216, 262, 000	454, 784	2, 669	457, 453
Pennsylvania	4, 341, 000		4, 341, 000	11, 718		11, 718
Puerto Rico	8, 000	5, 000	13, 000	94	5	99
South Carolina	1, 966, 000		1, 966, 000	10, 835		10, 835
South Dakota	27, 998, 000	262, 000	28, 260, 000	78, 292	269	78, 561
Tennessee	8, 281, 000		8, 281, 000	23, 712		23, 712
Texas	4, 177, 000		4, 177, 000	27, 236		27, 236
Utah	9, 616, 000	1, 361, 000	10, 977, 000	20, 934	1, 415	22, 349
Vermont	2, 638, 000		2, 638, 000	9, 157		9, 157
Virginia	11, 613, 000		11, 613, 000	15, 719		15, 719
Washington	165, 491, 000	234, 000	165, 725, 000	433, 847	193	434, 040
West Virginia	2, 254, 000		2, 254, 000	7, 076		7, 076
Wisconsin	3, 621, 000	8, 000	3, 629, 000	5, 601	9	5, 610
Wyoming	41, 883, 000	875, 000	42, 758, 000	83, 274	872	84, 146
Total, 1937	1, 077, 761, 000	19, 189, 000	1, 096, 950, 000	2, 722, 483	[1] 17, 320	2, 739, 803
Total, 1936	794, 853, 000	19, 932, 000	814, 785, 000	2, 100, 496	[1] 18, 651	2, 119, 147

[1] In addition, minor products not convertible into board feet were cut, the value of which was $39,309 in 1937 and $30,226 in 1936.

TABLE 9.—*Quantity and value of national-forest timber sold, fiscal year 1937*

State	Quantity sold			Value		
	Commercial sales	Cost sales	Total	Commercial sales	Cost sales	Total
	Board feet	*Board feet*	*Board feet*	*Dollars*	*Dollars*	*Dollars*
Alabama	224, 000		224, 000	1, 147		1, 147
Alaska	28, 148, 000		28, 148, 000	43, 100		43, 100
Arizona	59, 681, 000	527, 000	60, 208, 000	143, 750	539	144, 289
Arkansas	48, 099, 000	347, 000	48, 446, 000	797, 560	347	797, 907
California	179, 409, 000	1, 767, 000	181, 176, 000	274, 089	1, 406	275, 495
Colorado	83, 349, 000	572, 000	83, 921, 000	209, 062	576	209, 638
Florida	7, 962, 000		7, 962, 000	36, 622		36, 622
Georgia	1, 732, 000		1, 732, 000	7, 594		7, 594
Idaho	41, 400, 000	5, 210, 000	46, 610, 000	107, 401	5, 063	112, 464
Illinois	48, 000		48, 000	396		396
Indiana	4, 000		4, 000	57		57
Kentucky	518, 000		518, 000	1, 270		1, 270
Louisiana	7, 236, 000		7, 236, 000	57, 744		57, 744
Maine	344, 000		344, 000	1, 165		1, 165
Michigan	15, 518, 000	31, 000	15, 549, 000	31, 065	27	31, 092
Minnesota	24, 714, 000	48, 000	24, 762, 000	74, 330	36	74, 366
Mississippi	15, 562, 000		15, 562, 000	17, 381		17, 381
Missouri	525, 000	3, 000	528, 000	2, 120	4	2, 124
Montana	44, 383, 000	2, 927, 000	47, 310, 000	83, 916	2, 575	86, 491
Nebraska	13, 000		13, 000	25		25
Nevada	539, 000	191, 000	730, 000	527	128	655
New Hampshire	16, 569, 000		16, 569, 000	50, 940		50, 940
New Mexico	24, 394, 000	1, 253, 000	25, 647, 000	54, 672	1, 263	55, 935
North Carolina	25, 822, 000		25, 822, 000	47, 397		47, 397
Ohio	178, 000		178, 000	193		193
Oregon	192, 888, 000	3, 713, 000	196, 601, 000	559, 975	2, 693	562, 668
Pennsylvania	3, 682, 000		3, 682, 000	5, 891		5, 891
Puerto Rico	8, 000	5, 000	13, 000	94	5	99
South Carolina	7, 888, 000		7, 888, 000	53, 693		53, 693
South Dakota	39, 067, 000	202, 000	39, 269, 000	117, 159	207	117, 366
Tennessee	12, 017, 000		12, 017, 000	30, 858		30, 858
Texas	3, 044, 000		3, 044, 000	14, 965		14, 965
Utah	10, 491, 000	1, 278, 000	11, 769, 000	23, 517	1, 310	24, 827
Vermont	1, 463, 000		1, 463, 000	5, 628		5, 628
Virginia	19, 605, 000		19, 605, 000	19, 489		19, 489
Washington	525, 229, 000	236, 000	525, 465, 000	577, 406	189	577, 595
West Virginia	2, 598, 000		2, 598, 000	8, 358		8, 358
Wisconsin	8, 185, 000	8, 000	8, 193, 000	10, 940	9	10, 949
Wyoming	19, 273, 000	1, 085, 000	20, 358, 000	39, 162	1, 071	40, 233
Total, 1937	1, 471, 809, 000	19, 403, 000	1, 491, 212, 000	3, 510, 658	[1] 17, 448	3, 528, 106
Total, 1936	967, 828, 000	20, 476, 000	988, 304, 000	2, 364, 998	[1] 18, 475	2, 383, 473

[1] In addition, minor products not convertible into board feet were sold, valued at $25,879 in 1937, and $13,802 in 1936.

TABLE 10.—*Planting and sowing on national forests, by States, calendar year 1936*

State	Planted	Sown	Total	State	Planted	Sown	Total
	Acres	*Acres*	*Acres*		*Acres*	*Acres*	*Acres*
Arkansas	4,814		4,814	Ohio	104	222	326
California	1,202	2,001	3,203	Oregon	971		971
Colorado	2,519		2,519	Pennsylvania	1,143	80	1,223
Idaho	5,384		5,384	South Carolina	501		501
Illinois	1,168	591	1,759	South Dakota	845		845
Indiana	335	504	839	Tennessee	101		101
Louisiana	23,278		23,278	Texas	3,623		3,623
Michigan	78,197		78,197	Washington	3,066		3,066
Minnesota	11,647	63	11,710	West Virginia	1,431		1,431
Mississippi	22,597		22,597	Wisconsin	40,372		40,372
Missouri	3,080	5,195	8,275	Wyoming	219		219
Montana	1,442		1,442	Puerto Rico	3,825	65	3,890
Nebraska	1,770		1,770				
New Hampshire	528	48	576	Total	214,306	8,769	223,075
North Carolina	144		144				

TABLE 11.—*Forest Service nurseries, and annual output as approved for calendar year 1936*

No.	Nursery	Location	Approved annual output [1]
			1,000 trees
1	Susanville	Susanville, Calif	1,000
2	Wind River	Carson, Wash	3,500
3	Savenac	Haugen, Mont	10,000
4	McCall	McCall, Idaho	1,000
5	Tony Grove	Logan, Utah	2,000
6	Pole Mountain	Laramie, Wyo	280
7	Bessey	Halsey, Nebr	6,000
8	Monument	Monument, Colo	5,500
9	Coconino	Flagstaff, Ariz	500
10	Superior	Superior, Ariz	23
11	Glenwood	Glenwood, N. Mex	20
12	Cloudcroft	Cloudcroft, N. Mex	5
13	Towner	Towner, N. Dak	3,500
14	Lydick	Cass Lake, Minn	9,500
15	Cass Lake	do	
16	Eveleth	Eveleth, Minn	11,500
17	Knife River	Two Harbors, Minn	5,000
18	Hayward	Hayward, Wis	14,000
19	Butternut	Park Falls, Wis	14,000
20	Hugo Sauer	Rhinelander, Wis	12,500
21	Watersmeet	Watersmeet, Mich	14,000
22	Wyman	Manistique, Mich	16,000
23	Chittenden	Wellston, Mich	22,000
24	Beal	East Tawas, Mich	10,000
25	Chillicothe	Chillicothe, Ohio	8,500
26	Vallonia	Vallonia, Ind	9,000
27	Junction	Junction City, Ill.[2]	
28	Keosauqua	Ottumwa, Iowa	6,000
29	Licking	Licking, Mo	10,250
30	Ozark	Russellville, Ark	3,000
31	R. Y. Stuart	Alexandria, La	26,000
32	W. W. Ashe	Brooklyn, Miss	26,000
33	Parsons	Parsons, W. Va	5,000
	Total		255,578

[1] Based on need for planting in the area served by each nursery, and on available funds. Many nurseries are operating temporarily above or below approved annual output. Program is being adjusted toward figures shown.
[2] Abandoned in spring of 1937.

TABLE 12.—*Grazing permits issued and numbers of stock allowed under pay permits on the national forests, by States, calendar year 1936*

State	Cattle, horses, and swine				Sheep and goats		
	Permits issued	Stock grazed			Permits issued	Stock grazed	
		Cattle	Horses	Swine		Sheep	Goats
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Arizona	1,046	177,267	1,009	50	91	270,029	600
Arkansas	38	756	14				
California	1,609	135,042	3,730	80	246	312,110	399
Colorado	2,908	258,495	1,953		839	896,509	100
Florida	10	465					
Georgia	38	194		6	1	6	
Idaho	2,869	122,863	4,531		1,150	1,223,084	20
Maine	2	8					
Montana	1,845	108,747	5,568		375	500,469	
Nebraska	34	12,372	326				
Nevada	308	52,948	1,629		122	276,558	
New Hampshire	14	72	4				
New Mexico	2,045	86,584	1,894		260	186,746	6,988
North Carolina	49	423		23	4	10	
Oregon	1,072	80,353	1,083		392	547,496	6
Pennsylvania	3	38					
South Dakota	650	25,059	839		44	22,756	
Tennessee	23	350					
Utah	4,099	101,628	2,701		1,734	680,239	
Virginia	35	421	2		6	338	
Washington	418	14,566	332		88	125,688	
West Virginia	92	1,282	15		158	4,463	
Wyoming	852	102,607	2,638		314	590,436	
Total, 1936	20,059	1,282,540	28,268	159	5,824	5,636,937	8,113
Total, 1935	20,465	1,315,233	29,085	292	6,009	5,681,938	9,148

TABLE 13.—*Trends in range use of western national forests, 1926–36*

Year	Animal-months		Total reduced to cow-months	Year	Animal-months		Total reduced to cow-months
	Cattle and horses	Sheep and goats			Cattle and horses	Sheep and goats	
1926	9,521,253	20,666,133	13,654,480	1934	8,558,651	20,141,495	12,586,950
1927	9,039,596	20,209,935	13,081,583	1935	7,515,146	17,628,938	11,040,934
1928	8,407,668	21,230,434	12,643,755	1936	7,779,145	17,155,774	11,210,300
1929	7,979,431	20,744,076	12,128,246				
1930	8,417,461	21,259,351	12,669,331	Changes from—	*Percent*	*Percent*	*Percent*
1931	8,458,526	21,139,250	12,686,376	1926 to 1934	−10	−3	−8
1932	8,382,705	19,457,501	12,274,205	1926 to 1935	−21	−15	−19
1933	8,436,968	18,987,131	12,234,394	1926 to 1936	−18	−17	−18

TABLE 14.—*Livestock losses, 1936*

CATTLE AND HORSES

Region no.	From poisonous plants		From predatory animals		From disease		From other causes		Total	
	Number	Value	Number	Value	Number	Value	Number	Value	Number	Value
1	221	$7,735	26	$910	63	$2,205	546	$19,110	856	$29,960
2	2,621	91,735	145	5,075	916	32,060	1,791	62,685	5,473	191,555
3	908	31,780	1,028	35,980	554	19,390	1,555	54,425	4,045	141,575
4	1,551	54,285	111	3,885	169	5,915	1,387	48,545	3,218	112,630
5	367	12,845	82	2,870	117	4,095	599	20,965	1,165	40,775
6	137	4,795	10	350	121	4,235	748	26,180	1,016	35,560
Total, 1936	5,805	203,175	1,402	49,070	1,940	67,900	6,626	231,910	15,773	552,055
Total, 1935	7,320	219,600	1,577	47,310	2,417	72,510	7,327	219,810	18,641	559,230

SHEEP AND GOATS

1	4,722	23,610	9,744	48,720	783	3,915	9,554	47,770	24,803	124,015
2	8,538	42,690	16,095	80,475	3,619	18,095	11,250	56,250	39,502	197,510
3	1,005	5,025	1,954	9,770	556	2,780	660	3,300	4,175	20,875
4	10,505	52,525	37,745	188,725	4,420	22,100	17,955	89,775	70,625	353,125
5	1,096	5,480	4,395	21,975	1,001	5,005	2,568	12,840	9,060	45,300
6	3,319	16,595	8,471	42,355	1,903	9,515	7,039	35,195	20,732	103,660
Total, 1936	29,185	145,925	78,404	392,020	12,282	61,410	49,026	245,130	168,897	844,485
Total, 1935	28,819	144,095	64,008	320,040	13,332	66,660	45,251	226,255	151,410	757,050

TABLE 15.—*Estimate of big-game animals on national forests, as of Dec. 31, 1936*

SUMMARY BY REGIONS

Region or State	Antelope	Bear		Deer	Elk	Moose	Mountain goat	Mountain sheep
		Black or brown	Grizzly					
Region no.:	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
1	1,132	8,237	518	111,037	32,647	2,027	5,607	1,186
2	980	4,980	109	112,624	28,222	481	18	4,052
3	6,080	2,170	5	167,550	5,460			290
4	4,800	4,210	70	166,615	32,090	2,435	1,475	3,865
5	3,020	12,838		273,500	175			345
6	920	12,440	7	162,905	27,302		5,490	60
7		2,286		46,039	44	2		
8		790		34,049	35			
9		3,240		324,598	20	1,036		
10		6,700	[1] 4,500	42,850	60	535	5,800	1,575
All regions	16,932	57,891	5,209	1,441,767	126,055	6,516	18,390	11,373

SUMMARY BY STATES

Alabama				930				
Alaska		6,700	[1] 4,500	42,850	60	535	5,800	1,575
Arizona	5,040	820		81,090	4,605			175
Arkansas		6		6,277	17			
California	3,020	12,838		273,500	175			345
Colorado	212	3,936	7	82,300	16,879			2,510
Florida		110		8,675				
Georgia		5		448				
Idaho	4,425	5,563	67	88,427	19,370	705	3,347	1,920
Illinois				13				
Louisiana				283				
Maine		30		286				
Michigan		640		134,937	20			
Minnesota		1,750		98,839		1,036		
Mississippi				179				
Missouri				358				

[1] Includes Alaska brown bear.

TABLE 15.—*Estimate of big-game animals on national forests, as of Dec. 31, 1936*—Continued

Region or State	Antelope	Bear		Deer	Elk	Moose	Mountain goat	Mountain sheep
		Black or brown	Grizzly					
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Montana	1,132	5,159	466	79,330	19,271	1,657	3,715	966
Nebraska				264				
Nevada	200			12,200	140			200
New Hampshire		300		1,400				
New Mexico	1,040	1,350	5	86,460	855			115
North Carolina		631		11,945	18			
Ohio		5						
Oklahoma		5		1,400				
Oregon	920	5,490		116,840	15,552			50
Pennsylvania		250		38,958				
South Carolina		4		1,022				
South Dakota	14			5,450	417		18	
Tennessee		29		565				
Texas				2,325				
Utah	175	460		89,300	2,950			125
Vermont		100		1,000		2		
Virginia		755		2,230	44			
Washington		7,280	7	48,870	11,756		5,510	10
West Virginia		851		2,165				
Wisconsin		850		90,451				
Wyoming	754	1,979	157	30,200	33,926	2,581		3,382
All States	16,[illegible]32	57,891	[1] 5,209	1,441,767	126,055	6,516	18,390	11,373
Total, 1935	16,598	55,079	[1] 5,269	1,291,329	117,916	6,186	18,511	12,924

TABLE 16.—*Appropriations for State cooperation, fiscal years 1936–38*

Item	Amount appropriated for the fiscal year—		
	1936	1937	1938
For prevention and suppression of forest fires, and for forest-taxation inquiry and insurance study (secs. 1–3, Clarke-McNary law)	$1,578,632	$1,655,007	$1,655,007
For distribution of forest planting stock to farmers (sec. 4, Clarke-McNary law)	56,379	70,579	70,579
For farm-forestry extension (sec. 5, Clarke-McNary law, administered by Division of Cooperative Extension)	56,838	56,838	56,838

TABLE 17.—*Cooperative expenditures for fire protection and distribution of forest-planting stock under the Clarke-McNary Act, fiscal year 1937*

State	For fire protection				For the distribution of forest-planting stock [1]		
	Federal	State	Private agencies	Total	Federal	State	Total
Alabama	$36,530.00	$22,951.82	$28,851.04	$88,332.86	$513.71	$2,749.26	$3,262.97
Arkansas	41,560.00	16,048.42	45,709.64	103,318.06	1,852.00	8,634.61	10,486.61
California	152,393.00	588,625.16	12,693.53	753,711.69			
Colorado					1,708.00	5,094.30	6,802.30
Connecticut	16,053.00	57,764.07	2,847.05	76,664.12	194.00	198.38	392.38
Delaware	1,630.00	7,066.08		8,696.08	1,467.95	1,467.94	2,935.89
Florida	70,780.00	110,131.10	61,127.81	242,038.91	1,834.00	6,758.67	8,592.67
Georgia	69,843.00	19,552.92	66,990.19	156,386.11	1,779.00	6,214.65	7,993.65
Hawaii	994.00	2,585.49		3,579.49	900.00	932.23	1,832.23
Idaho	53,349.00	65,247.11	91,567.00	210,163.11	1,600.00	2,468.21	4,068.21
Indiana	6,720.00	23,752.08		30,472.08	1,886.00	9,449.90	11,335.90
Iowa					1,600.00	19,199.47	20,799.47
Kansas					1,734.00	7,234.97	8,968.97

[1] A total of 35,647,809 trees were distributed during the calendar year 1936. The State of New York led with a distribution of 3,845,500 trees under this cooperative program.

TABLE 17.—*Cooperative expenditures for fire protection and distribution of forest-planting stock under the Clarke-McNary Act, fiscal year 1937*—Continued

State	For fire protection				For the distribution of forest-planting stock		
	Federal	State	Private agencies	Total	Federal	State	Total
Kentucky	12,460.00	12,721.08		25,181.08	1,654.00	2,480.10	4,134.10
Louisiana	42,408.00	63,415.88	32,098.82	137,922.70	1,600.00	8,511.44	10,111.44
Maine	49,796.00	128,817.84		178,613.84	513.94	513.91	1,027.85
Maryland	12,123.00	36,717.37	283.02	49,128.39	1,600.00	3,649.90	5,249.90
Massachusetts	23,822.00	112,396.37		136,218.37	1,744.00	6,852.93	8,596.93
Michigan	108,515.00	458,709.56		567,224.56	1,889.00	7,079.89	8,968.89
Minnesota	85,393.00	665,966.10		751,359.10			
Mississippi	45,040.00	18,188.13	52,346.32	115,574.45	1,383.64	1,549.23	2,932.87
Montana	23,742.00	18,857.43	55,159.73	97,759.16	1,709.00	6,098.41	7,807.41
Nebraska					2,224.00	17,608.28	19,832.28
Nevada	1,755.00	211.00	4,629.60	6,595.60			
New Hampshire	15,297.00	28,990.48	5,704.81	49,992.29	1,740.00	3,055.58	4,795.58
New Jersey	23,208.00	140,646.88		163,854.88	1,953.00	9,701.66	11,654.66
New Mexico	2,080.00	1,918.28	416.13	4,414.41			
New York	63,133.00	261,876.71		325,009.71	1,903.00	6,122.82	8,025.82
North Carolina	51,560.00	94,554.50	14,784.53	160,899.03	1,721.00	5,637.43	7,358.43
North Dakota					1,829.00	7,249.21	9,078.21
Ohio	5,600.00	14,092.78		19,692.78	1,913.00	12,439.93	14,352.93
Oklahoma	13,253.40	7,253.43	6,000.00	26,506.83	1,693.00	5,184.96	6,877.96
Oregon	81,311.00	54,137.15	298,060.65	433,508.80	1,600.00	2,063.71	3,663.71
Pennsylvania	47,368.00	204,094.16		251,462.16	1,876.00	11,044.57	12,920.57
Puerto Rico					2,022.00	11,887.09	13,909.09
Rhode Island	2,290.00	13,715.92		16,005.92			
South Carolina	32,820.00	61,357.20	20,954.67	115,131.87	1,685.00	6,028.06	7,713.06
South Dakota	850.00	2,018.90		2,868.90	1,815.00	8,585.70	10,400.70
Tennessee	19,600.00	75,987.70	630.52	96,218.22	1,736.00	6,934.29	8,670.29
Texas	39,701.00	105,518.14	9,215.00	154,434.14	1,600.00	2,581.66	4,181.66
Utah					1,666.00	3,653.33	5,319.33
Vermont	5,500.00	9,048.45	3,153.04	17,701.49	1,535.00	3,475.64	5,010.64
Virginia	31,760.00	45,625.39	1,642.00	79,027.39	1,600.00	1,974.42	3,574.42
Washington	86,746.00	107,050.51	387,995.07	581,791.58	1,643.20	3,970.45	5,613.65
West Virginia	32,504.00	69,053.10	24,814.00	126,371.10	1,704.00	3,119.90	4,823.90
Wisconsin	62,858.00	424,977.76		487,835.76	1,687.00	8,469.55	10,156.55
Wyoming					1,312.50	2,331.76	3,644.26
Administration and inspection	131,881.57			131,881.57	2,737.74		2,737.74
Total	1,604,231.97	4,151,642.45	1,227,674.17	6,983,548.59	70,357.68	250,258.40	320,616.08
Forest-taxation and insurance study	44,642.00						
Impoundment	5,800.00						
Unexpended balance	333.03				221.32		
Total appropriation	1,655,007.00				70,579.00		

TABLE 18.—*Prairie States forestry project, Shelterbelt plantings, spring of 1937*

DATA FOR 1937

State	Shelterbelt	Plantations	Farms served	Trees planted— In new plantations	In replacements, completions, and improvements	Total
	Miles	*Acres*	*Number*	*Number*	*Number*	*Number*
North Dakota	82.0	902	114	720,000	3,210,000	3,930,000
South Dakota	144.0	1,728	290	1,583,900	2,481,800	4,065,700
Nebraska	338.6	4,087	529	2,050,593	1,421,351	3,471,944
Kansas	201.6	2,333	367	1,210,674	2,046,545	3,257,219
Oklahoma	332.9	3,672	585	1,837,220	1,214,396	3,051,616
Texas	225.5	2,561	280	1,340,033	1,290,475	2,630,508
Total	1,324.6	15,283	2,165	8,742,420	11,664,567	20,406,987

SUMMARY FOR PREVIOUS YEARS (ALL STATES)

1935	125.0	7,514	2,152	5,615,183		5,615,183
1936	1,152.8	24,521	2,212	17,526,068	629,810	18,155,878
Grand total	2,602.4	47,318	6,529	31,883,671	12,294,377	44,178,048

TABLE 19.—*Average yearly number and distribution of Civilian Conservation Corps camps maintained for forestry work during the 4 years ended, respectively, Mar. 31, 1934, 1935, 1936, and 1937*

Class of work	1934	1935	1936	1937
	Number	*Number*	*Number*	*Number*
National forest	525	471	644	481
State forest	319	305	366	286
Private forest	221	171	230	171
Tennessee Valley Authority	20	21	34	26
Total	1,085	968	1,274	964

Expenditures by classes, fiscal year 1937

Expenditures during the fiscal year were as follows:

General administration			$1,206,041.31
Administration, protection, improvement, reforestation, and extension of national forests:			
Operating expenditures:			
Timber use	$1,471,452.18		
Grazing use	1,113,808.50		
Recreation and land use	855,752.34		
Fish and game protection	642,728.90		
Classification, settlement, and claims	128,409.62		
Maintenance of truck and horse trails	3,386,771.05		
Maintenance of other improvements	1,671,220.42		
Subtotal		$9,270,143.01	
Protection expenditures:			
Fire prevention and detection	$5,266,025.70		
Fire suppression	1,693,703.09		
Class total (fire)	6,959,728.79		
Protection against insects and tree diseases	131,528.63		
Subtotal		7,091,257.42	
Investment expenditures:			
Construction of truck and horse trails	$12,633,627.96		
Construction of other structural improvements	11,318,856.09		
Equipment and stores	5,348,658.90		
Timber surveys and plans	566,033.39		
Grazing surveys and plans	134,137.80		
Fish and game surveys and plans	267,955.76		
Recreational-use surveys and plans	233,934.37		
General surveys and plans	561,049.70		
Timber-stand improvement	892,107.51		
Reforestation of denuded areas	1,137,319.25		
Nurseries and planting stock	396,381.84		
Acquisition of land by direct purchase	15,253,945.47		
Acquisition of land by exchange	[1] 98,692.71		
Nonstructural improvements (erosion, tree-disease and insect control, fire-hazard reduction, and miscellaneous investments not otherwise classified)	5,067,901.48		
Subtotal		53,910,602.23	
Construction and maintenance of forest highways:			
Construction of forest highways	$7,601,526.54		
Maintenance of forest highways	913,016.82		
Subtotal		8,514,543.36	
Total, national forests			78,786,546.02
Prairie States Forestry Project (including nurseries):			
Current expenditures:			
General administration	$71,265.35		
Maintenance of improvements	330,925.00		
Subtotal		$402,190.35	
Investment expenditures:			
Construction of other improvements	$142,937.74		
Equipment and stores	160,473.66		
Reforestation of denuded areas	664,166.57		
Nurseries and planting stock	358,319.40		
Nonstructural improvements (erosion, tree-disease and insect control, fire-hazard reduction, and miscellaneous investments not otherwise classified)	2,563.06		
Subtotal		1,328,460.43	
Total, Prairie States Forestry Project			1,730,650.78

[1] In addition to the expenditure for acquisition of land by exchange, national-forest timber having an estimated value of $448,869 was cut under agreements involving the acquisition of land and timber through exchange. Cash expenditures recorded opposite Acquisition of land by exchange cover merely the outlay incidental to examining lands offered for exchange and appraising the value involved.

Expenditures by classes, fiscal year 1937—Continued

Research:			
Research current expenditures:			
Forest management	$1,850,455.50		
Range investigations	319,353.28		
Forest products	101,432.18		
Forest survey	573,769.70		
Forest economics	115,402.82		
Forest influences	302,833.25		
Forest taxation and insurance	38,635.00		
Maintenance of roads and trails	14,870.21		
Maintenance of other improvements	81,684.12		
Fire prevention and detection on experimental areas	3,312.14		
Subtotal		$3,401,748.20	
Research investments:			
Construction of roads and trails	$13,722.60		
Construction of other improvements	473,648.43		
Equipment and stores	248,654.19		
Timber surveys and plans, experimental areas	8,467.53		
General surveys and plans, experimental areas	57,941.15		
Timber-stand improvement, experimental areas	4,871.70		
Nonstructural improvements on experimental areas (erosion, tree-disease and insect control, fire-hazard reduction, and miscellaneous investments not otherwise classified)	84,677.79		
Subtotal		891,983.39	
Total			$4,293,731.59
Protection and reforestation of other than national-forest lands:			
Tree planting in cooperation with States and others		$94,418.42	
Fire protection in cooperation with States and others		1,848,742.48	
Protection of Oregon and California grant lands		82,982.56	
Extension of forestry practice on State and private lands		302,151.37	
Total			2,328,294.83
Emergency Conservation Work on other than national-forest lands:			
State and private camp expenditures		$16,371,943.30	
Total			16,371,943.30
Miscellaneous:			
Emergency unemployment relief; cooperation with other agencies in connection with Emergency Conservation Work for which these agencies are responsible		$382,273.49	
Emergency unemployment relief; Federal Emergency Relief Administration, etc		178,505.67	
Tennessee Valley Authority; Emergency Conservation Work		601,392.77	
Insular Forests, Puerto Rico; Emergency Conservation Work		398,561.95	
Navy Department; Emergency Conservation Work		96,761.39	
War Department; Mississippi floodway land appraisal		79,195.41	
Examination and administration of power sites for Federal Power Commission		10,436.28	
Miscellaneous cooperation with other departments, bureaus, and individuals		1,603,968.07	
Total			3,351,095.03
Grand total			108,068,302.86

Expenditures by sources, fiscal year 1937

Preceding expenditures were authorized by diverse acts of Congress, some directly appropriating funds for the Forest Service, some placing funds initially at the disposal of other agencies. Each appropriation item and each allocation of funds is necessarily handled as a separate account, to assure that all disbursements are made in accordance with the law governing the use of the particular fund drawn upon. Space limitations of this report prevent a full showing of the legislative source of each fund and of the legislative authority to make the expenditures shown, for the purposes shown. All that can be done here is to list the expenditures of the year, from the standpoint of source, under the abbreviated captions used within the Forest Service to distinguish the individual accounts. To those familiar with the work of the Service, these captions will, in varying degree, be self-explanatory.

Expenditures by sources, fiscal year 1937—Continued

Salaries and expenses, Office of Solicitor	$28, 299. 40
Salaries and expenses, District of Columbia	565, 232. 00
Salaries and expenses, regional (protection and administration)	10, 704, 728. 89
Fire fighting	1, 916, 520. 86
Forest products	606, 258. 66
Range investigations	181, 082. 22
Forest management	618, 625. 47
Forest survey	199, 551. 21
Forest economics	90, 666. 60
Forest influences	98, 664. 87
Water rights	8, 991. 96
Cooperative distribution of planting stock	70, 307. 58
Forest-fire cooperation	1, 647, 345. 26
Forest-road development	2, 643, 444. 01
Forest highways	142, 922. 90
Cooperative work, Forest Service	718, 309. 98
Roads and trails for States (10 percent)	398, 060. 98
Acquisition of lands (no year)	15, 814. 88
Acquisition of lands, 1937	1, 005, 682. 18
Cooperative repayments	90, 461. 76
Undeposited cooperation	1, 583, 241. 88
Conservation and use of agricultural land resources, 1936–37	470, 796. 86
Special research fund, Department of Agriculture	2, 540. 32
Working fund, flood control, Mississippi River	78, 010. 45
Working fund, Federal Power Commission	1, 005. 77
Salaries and expenses, Soil Conservation Service	52, 099. 80
Working fund, Department of Justice	29, 473. 52
Acquisition of lands, Uinta and Wasatch National Forests	47, 620. 18
N. I. R. A.:	
Highways	1, 270. 35
Development	11, 024. 42
Forest Service	7, 419. 88
Forest Service	2, 955. 59
Emergency highways, act of June 19, 1934	26, 267. 39
Emergency development roads, act of June 19, 1934	93, 412. 10
Emergency Conservation funds:	
Acquisition, 1935—Mar. 31, 1937	11, 932. 39
Acquisition, 1935—Mar. 31, 1937 (Jefferson National Forest)	60, 000. 00
Other, 1937, Mar. 31, 1937	19, 751, 775. 98
Other, act of Feb. 9, 1937	6, 679, 495. 46
State, 1937, Mar. 31, 1937	12, 635, 243. 58
State, act of Feb. 9, 1937	4, 014, 927. 32
Emergency relief:	
Administrative expenses 1935–37	690, 196. 22
Administrative expenses 1936–38	472, 544. 81
Transient 1935–37	114, 660. 95
Forestation 1935–37	7, 920, 884. 21
Forestation 1936–37	16, 369, 810. 27
Rural rehabilitation, Resettlement Administration, 1935–37	303, 348. 63
Rural rehabilitation, Resettlement Administration, 1936–37	234, 428. 19
Works Progress Administration	20, 218. 39
Expenditures 1937 from appropriations of previous years (obligated in previous years but not included in previous expenditure reports):	
Emergency Conservation Fund:	
Acquisition	7, 222, 395. 92
Expenditures by Bureau of Public Roads for forest highways:	
Forest highways	5, 550, 097. 24
Forest road development	2, 241. 42
Roads and trails for States (10 percent)	29, 538. 13
Cooperative work, Forest Service	336, 318. 72
Undeposited cooperation	420, 062. 83
N. I. R. A. highways	272, 189. 53
Emergency highways act of June 19, 1934	797, 882. 49
Total	108, 068, 302. 86
Summary of expenditures by appropriations:	
Regular annual appropriations	18, 345. 493. 61
Regular continuing appropriations	8, 860, 130. 01
Cooperation (deposited, undeposited, repayments, etc.)	3, 148, 395. 17
Emergency appropriations (Emergency Conservation work on other than national-forest lands)	16, 650, 170. 90
Emergency appropriations (all other)	53, 841, 717. 25
1937 expenditures from 1935 emergency appropriations (obligated in 1935 but not previously reported as expenditures)	7, 222, 395. 92
Total	108, 068, 302. 86

Gross and net cash receipts from national forests, fiscal year 1937

Gross receipts from national forests:	
From the use of timber	$2,924,470.87
From the use of forage	1,580,345.07
From special land uses, water power, etc	431,367.12
Total	4,936,183.06
Less payments to States:	
To Arizona and New Mexico, account school lands administered by Forest Service	27,995.05
To States in which national forests are located under act of May 23, 1908	[1] 1,214,547.00
Total to States	1,242,542.05
Net total receipts to United States Treasury	3,693,641.01

[1] Computed on basis of total receipts less (1) payments to Arizona and New Mexico on account of school lands administered by Forest Service, and (2) portion of receipts from Uinta and Wasatch National Forests during the fiscal year appropriated in the appropriation act for Department of Agriculture, fiscal year 1937, for acquisition of lands, and authorized by act of Aug. 26, 1935 (49 Stat. 866), $50,000.

The total of the gross is greater by $873,219.88 than that for the previous year. Receipts from timber increased $721,233.81. Grazing receipts increased $138,851.84 and miscellaneous receipts increased $13,134.23.

In addition to cash receipts from timber, there should be credited the value of the timber cut under specific agreements for effecting land exchanges, estimated at $448,869.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - Price 10 cents

REPORT OF THE CHIEF OF THE BUREAU OF HOME ECONOMICS, 1937

United States Department of Agriculture,
Bureau of Home Economics,
Washington, D. C., September 15, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I submit herewith the report of the Bureau of Home Economics for the fiscal year ended June 30, 1937.

Louise Stanley, *Chief.*

CONTENTS

INTRODUCTION

Increased well-being of its people is a fundamental goal of a democracy. Those responsible for public policies, therefore, are concerned with such questions as whether the Nation's productive capacities are adequate and so adjusted as to provide satisfactory levels of living for the entire population—not merely for a small group. To shed light on this question they seek facts as to the income families receive, how these incomes are spent, and whether they are adequate to provide satisfactory family living. They seek also to formulate policies for raising living levels, through efforts of families themselves and through wiser use of our national resources. Formulation of such policies calls for fact-finding along many lines and for governmental research supplementing that of other agencies.

The Bureau of Home Economics, concentrating its attention on families, studies their consumption, the relation between their incomes or ability to buy and their purchases; it evaluates family living both from the standpoint of choices and of market offerings. Its research findings are made effective in improving national well-being in three ways: (1) Through furnishing basic data to agencies responsible for formulating public policies; (2) through pointing out to producers how to fit their programs to people's needs and desires; and (3) through giving facts on food, human nutrition, clothing, and other household commodities and services to families so that they may choose and use goods more wisely.

Especially important to agriculture is the study of incomes and consumption patterns of farm families. The levels of living achieved furnish a yardstick for measuring the success of any agricultural program, for judging whether the land has produced a satisfactory level of living for the population engaged in various types of agriculture.

For administrative purposes the Bureau's work is divided in four categories: (1) Foods and nutrition, (2) economic studies, (3) textiles and clothing, and

(4) housing and household equipment. The publications and information services stem from these four divisions. They represent the Bureau's research, which in turn is unified through its concentration on the goal of higher levels of living for all of the Nation's families.

FOODS AND NUTRITION

The work in foods and nutrition is organized with a view to adding to the knowledge of the specific nutritive requirements of man, and to determining ways of meeting these requirements through intelligent food selection and scientific preparation. Such information is significant for the population because of the relation of diet to good nutrition and general well-being, regardless of the level of food expenditure. It is especially significant in the planning of diets for individuals in public institutions and for families dependent on public aid, when it is important to know what are minimum requirements and how they can be inexpensively met. Scientific knowledge is also needed in correlating actual food consumption with food requirements for the country as a whole.

Investigations are under way to determine the significance in human nutrition of trace elements and other unidentified factors which consistently occur in foods. Methods are being developed for measuring the adequacies of the intake of different vitamins. These methods must be applied by direct studies on human subjects to determine vitamin requirements.

The newer developments in nutrition have emphasized the increased importance of studies showing the relation of various production factors (as cultural conditions, feeding practices, and species and variety of plant or animal) to variations in the nutritive value of foods. Changes in methods of processing and the increase in the number of food products on the market necessitate frequent revision of the data on food composition and indicate the need for new information on food utilization. To keep in step with these changes, the work of this Bureau in foods and nutrition has during the last year been more closely lined up with the work of production branches of the Department.

FOOD COMPOSITION

The objective of the food-composition studies is to bring together and analyze all available data on the chemical constituents of foods insofar as they affect nutritive value. There has been a growing interest in mineral constituents and a recognition of the need for further information on the influence of production factors on these food constituents. From the data that had been collected certain pertinent material was turned over to the Bureau of Chemistry and Soils for use in its study of the mineral composition of foods in relation to soils and soil treatment. Additional unpublished records were assembled and the literature was searched for pertinent authentic data on the mineral content of foods. Calcium and phosphorus were determined in several vegetables for which there were no adequate data.

To meet the need for information on the composition of cooked meats and poultry for use in diet calculations, data on their proximate composition were prepared for publication. This report not only gives the data on composition but also presents a simplified classification of these cooked foods.

There is an urgent demand on the part of individual consumers, nutritionists, dietitians, and physicians for a bulletin on food composition that will serve as a daily handbook. Accordingly data have been brought together and reviewed on a number of cereals and cereal products, several kinds and classes of poultry, nuts, dried and canned fruits and vegetables, cooked meats, and fresh pork. These new food-composition tables with accompanying text will furnish data in practical and usable form, materially better than those now given in textbooks on nutrition and diet.

NUTRITION STUDIES

The need for more exact information on the vitamin requirements of man is indicated by reports that relatively large proportions of the population are affected with subclinical manifestations of vitamin deficiencies. Extensive research is necessary to determine exact human requirements for each of the vitamins. A beginning has been made with vitamin A.

The earliest sign of vitamin A deficiency is revealed by a subnormal rate of visual adaptation to darkness. Studies are under way to determine the daily intake of vitamin A necessary to maintain a normal rate of dark adap-

tation. These studies have indicated the necessity for the development of specific and quantitative methods for the measurement of this rate before extensive metabolic studies are undertaken. Investigations are therefore being made of means by which the adequacy of vitamin A can be determined.

In addition to the chemically identified vitamins several other vitamins are known to occur persistently in a wide range of natural food products. Concentrates of an unidentified factor (or factors) previously associated with the vitamin B complex have been prepared from rice polishings. Studies to determine more accurately the properties and nutritional significance of these unidentified factors will be continued.

Natural food products consistently carry traces of inorganic elements. A special study is being made of the vanadium content of foods and its relation to good nutrition. The United States Public Health Service is cooperating by making histological examinations of the tissue of animals that have been fed different quantities of vanadium. Results so far show that minute amounts of vanadium are tolerated by animals but larger amounts are toxic.

In line with the importance of studying the factors that determine nutritive value of foods, arrangements were made for continuing the study of the vitamin C content of citrus hybrids in cooperation with the Bureau of Plant Industry. Two shipments of fruit were received and analyzed, a part of one shipment being analyzed as individual fruits. There was considerable variation in vitamin C content from fruit to fruit. In certain cases this individual variation was greater than the differences between some of the varieties. Plans are being made to continue the study to determine the factors that influence variation in samples of a given variety.

Studies of ascorbic acid content of citrus hybrids and of home-canned tomatoes have been published. Several brands of commercially canned tomatoes and tomato juice bought on the Washington, D. C., retail market were assayed for vitamin C by the modified technique of Musulin and King. Samples were selected at regular intervals over a period of several months. The vitamin C content of the different samples of a given brand was remarkably uniform.

Studies on the vitamin A, B, and D content of almonds, black walnuts, Brazil nuts, filberts, Persian (English) walnuts, peanuts, and pecans were completed. Vitamin G tests, however, were suspended awaiting further research on vitamin G technique. It is difficult to provide a diet adequate in all factors of the vitamin B complex except in vitamin G (riboflavin). Procedures are under way to free constituents of the diet of traces of vitamin G and to obtain fractions supplying the factors missing in the diet formerly used. These studies should render the technique more sensitive and more specific.

In making vitamin B determinations of nuts, dried yeast was used as a reference substance. This yeast is now being assayed against the International Standard vitamin B. Cooperative work with the vitamin assay committee of the United States Pharmacopeia on vitamin B has continued.

Preliminary studies on the vitamin content of five varieties of soybeans showed soybeans to be good sources of vitamins A and B. Assays for other vitamins and on additional varieties will be made when adequate plans can be developed through a cooperative arrangement with the Bureau of Plant Industry for obtaining fresh samples of a number of varieties for testing, and when a more satisfactory vitamin G technique has been worked out.

Studies were initiated to determine the losses of vitamins A, B, and C in vegetables cooked by different methods. Carrots were selected for the first studies.

Samples of brown rice and puffed rice prepared from the corresponding lot of rice have been assayed for vitamin B. The brown rice samples assayed fairly high in vitamin B, while the puffed rice contained very little of this factor.

The compilation of data on the vitamin content of foods was completed to 1936 and published by the Department. This includes a summary of the chemistry of vitamins, units of measurement, quantitative aspects in human nutrition, and occurrence in foods. The compilation of such data will be continued so that this publication may be revised periodically.

A beginning was made on assembling records on research in home economics in nonland-grant as well as land-grant institutions, in cooperation with committees of the American Home Economics Association and the Association of Land-Grant Colleges.

FOOD UTILIZATION

The research of the food-utilization section has continued along three lines: Investigations of food quality, and principles and methods of food preparation and of food preservation.

MEAT-QUALITY STUDIES

In the study of meat quality, the long-time cooperative project with the Bureaus of Animal Industry and Agricultural Economics and various State agricultural experiment stations, over 600 cuts from experimental animals were cooked. The object was to determine the loss of weight during cooking and the palatability of the meat as affected by the breed, sex, feed, and age of the animals and by different methods of ripening, curing, and storing the meat.

The results of a study of the relation of degree of finish in cattle to factors of palatability showed in general a progressive improvement in the meat associated with increase in fatness. Another study showed that retarding the growth of lambs made the meat less desirable in flavor. Lambs fed grain with roughage rations in restricted amounts produced less tender meat than those full-fed the same ration.

The study of factors that influence cooking shrinkage and cooking time of meat was continued. Data obtained in experiments on 600 rib roasts of beef were examined to show the role of water content, fat content, temperature of a roast when put into the oven, weight, style of cutting, and cooking temperature. Cooking temperature influenced shrinkage and cooking time more than did any of the other factors studied. In general, the higher the oven temperature, the greater was the shrinkage of beef and the more rapid the cooking. Also, the more thoroughly the beef was cooked, the more it shrank and the longer was the time required.

For example, when constant-temperature roasting methods were used, with oven temperatures ranging from 125° to 235° C., the shrinkage of standing and rolled roasts cooked rare at the center varied from 9 to 32 percent and required from 34 to 13 minutes per pound. Similar cuts cooked well-done with oven temperatures ranging from 125° to 175° C., shrank from 20 to 35 percent and required from 52 to 27 minutes per pound.

When roasting methods included initial searing at high temperature and the oven temperature for finishing the cooking varied from 125° to 225° C., shrinkage ranged from 11 to 24 percent and time from 45 to 13 minutes per pound, for standing and rolled roasts cooked rare at the center. Cooked well-done by a quick-sear and moderate-finish method, standing and rolled roasts shrank from 20 to 33 percent, and required from 61 to 28 minutes per pound.

EGGS

Through a cooperative arrangement with the Bureau of Animal Industry, eggs of known freshness from hens on a known diet were provided from the experiment farm at Beltsville, Md. The whites of these eggs were used for measurements of the volume and stability of foams beaten for different periods using thin, thick, and whole egg whites with total solids content adjusted to 8 and 12 percent. The results showed that 90 seconds, under the conditions of the experiment, gave foams having the best texture and approximately the optimum volume and stability.

The addition of cream of tartar and salt, in quantities used in foams for angel-food cakes, to egg whites of the types described above produced foams of greater volume and stability. The 90-second beating time was also found to be most desirable for these foams.

POTATOES

The studies on potatoes made cooperatively with the Bureau of Plant Industry to determine the influence of production factors on table quality have continued. The results of the study of quality of potatoes in relation to cultural methods showed no relationship between depth of planting and table quality.

The varietal-selection study included judgments for cooking quality of 8 commercial varieties and 10 seedlings produced by the Bureau of Plant Industry, which field tests have shown to have commercial possibilities. Data are being accumulated to show variations in cooking quality of certain commercial varieties of potatoes from year to year.

Comparative cooking tests were made on 13 lots of Irish Cobbler and Green Mountain potatoes to determine the effect of varying ratios of potash on internal blackening following cooking. The results did not show a clear-cut influence from the potash in the soil.

SOYBEANS

Cooperation with the Bureau of Plant Industry in providing different varieties of soybeans for quality tests has continued. This year nine varieties of soybeans and flour made from them were supplied. Our study showed that, of these nine varieties, some made a more satisfactory flour for use in baked products than others. Biscuits and muffins in which 50 percent of the flour was soybean were considered to be very good when made from five of the varieties of beans. The beans which retained a green color when mature did not make desirable flours.

BREAD

The Food Utilization Section continued its cooperation with the departmental committee appointed in the summer of 1935 to study factors that contribute to the flavor of bread. Last year 96 individuals tested bread, using the consumer-preference method of judging as summarized in the 1936 report. It seemed desirable this year to test a number of individuals for their acuity of sense of taste and of smell, in order to obtain a reliable panel of judges for the bread study. To test sensitivity of taste 64 prospective judges evaluated their sensations and identified in duplicate solutions of chemically pure sodium chloride, sucrose, lactic acid, and caffeine, tasted in order of increasing strength. To test acuity of sense of smell, they identified by odor eight familiar substances. Elimination of individuals who lacked consistence in taste sense and acuity-of-smell sense reduced the group to 25 persons. This group was tested further to establish its discriminatory powers by having each person rate in duplicate bread samples containing different quantities of sodium chloride, sucrose, lactic acid, and caffeine, respectively. Using this method to eliminate the indiscriminating persons reduced the final panel to 14 members.

Analyses of the data on the identification of the chemically pure solutions showed no cases of taste blindness for any one of the four substances. Smoking, age, and sex did not have a significant effect upon the individual thresholds for sweet, salt, acid, or bitter.

The results of these tests of the acuity of sense and smell are significant not only in connection with the selection of judges for the bread study, but also because they point the way to a suitable method of setting up a panel of judges for other food-quality studies.

COMMERCIALLY PREPARED FOODS

A comparison of homemade versus commercially-prepared ice-cream mixes, starch and gelatin puddings, gingerbread, devil's-food cake, and quick bread mixes, showed that in general, the homemade were better than the commercially-prepared mixtures. Flavor was the quality factor which gave low scores to many of the commercially-prepared products, but usually poor flavor was accompanied by inferior appearance, texture, or consistency, and color. The time of preparation of the commercially-prepared products as compared with the homemade varied with the complexity of the recipe, but was always less with the commercially-prepared foods.

There was no relationship between the cost and quality of the commercially-prepared foods. In many cases the cheapest product produced the highest quality. The cost range for a prepared unit of the same product from different brands was wide. Except for very few products, the cost of the commercially-prepared products was greater than the homemade.

CANNING

The study of the effect of the length of the canning process on the quality of beef was continued, using similar muscles from the round of beef. The processing periods compared were: No. 2 cans for 60 minutes and for 85 minutes at 250° F. The results confirmed those of the previous year, in that there was little difference in the quality of the canned meat from the same muscle when processed the two different periods.

ECONOMIC STUDIES

CONSUMER-PURCHASES STUDY

The promotion of family well-being, one of the chief functions of home economics, is contingent on definite knowledge of existing conditions and on possibilities for improvement. Our knowledge of prevailing levels of living has been greatly increased during the year through study of the consumption of families in different sections of the country, as influenced by income, family type, occupation, and degree of urbanization.

In this study, a Federal Works project sponsored by several Federal agencies, facts have been accumulated on income and household composition from random samples including almost 20,000 families in 19 small cities, 23,000 families in 140 villages, and 35,000 farm families in 19 farming areas. From a controlled sample within these groups data have been obtained on expenditures for the chief goods and services used from more than 35,000 families; on the kinds and quantities of food consumed during the week preceding the interview from about 17,000 families; on clothing purchases for different members of the family, from almost 22,000 families; and on furnishings and household-equipment purchases from 24,000 families. The expenditure study was limited to native-born nonrelief families having both husband and wife. Only white families were studied except in the Southeast where Negroes also were included.

The analysis of these data is well under way. Preliminary releases consisting of tabular material with explanatory statements have already been issued in mimeographed form for the use of governmental agencies and others wishing to make immediate use of the findings. The preparation of final reports is well advanced. The first publications will present by regions data on the expenditures and income of families in small cities and villages, and on farms.

Of particular interest to various governmental agencies are some of the details of the new data on farm-family income. There have never been satisfactory figures on the income of farmers from nonagricultural sources. As a result of this study there will be available for selected areas in each of 21 States figures on the net money income from nonfarm sources, as well as information on the money and nonmoney income from the farm.

In table 1 is shown for a few of the areas studied the average total income of nonrelief families who were not "in the red" in 1935–36, and the distribution of this income according to source. The sample included native unbroken families on farms for at least 1 year. They were white families except in the Southeast.

TABLE 1.—*Average total income of nonrelief farm families in specified localities, by source of income*

State and county	Average size of family	Average income				
		Total (money and nonmoney)	Nonmoney (from farm)	Net money income		
				Total	From farm	From other sources
	Persons	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Ohio: Crawford, Knox, Richland	3.9	1,365	572	793	599	194
Pennsylvania: Lancaster	4.7	1,661	647	1,014	742	272
Iowa: Madison, Mahaska, Marion, Marshall, Poweshiek	3.9	1,149	536	613	541	72
North Dakota: Barnes, Cass, Griggs, Steele	4.5	915	570	345	285	60
North Carolina: Macon, Jackson	5.2	1,004	610	394	87	307
South Carolina: Darlington, Florence (Negro)	6.7	667	349	318	270	48

The average total income during 1935–36 ranged from more than $400 per capita yearly, in Pennsylvania, to less than $100 among South Carolina Negro operators; the average per capita cash income ranged from $250 (Pennsylvania) to $46 (North Dakota). In the commercial farming areas listed in table 1, the money from nonfarm sources amounted only to one-sixth or one-fourth

of the total money income, but in self-sufficing farm areas it was the major source of cash.

Nonmoney income from the farm consists not only of the value of products furnished by the farm for family use but the change in value of crops stored for sale and of livestock inventories, and also of an imputed value of the occupancy of the farmhouse. This nonmoney income amounted to as much as $160 per capita yearly in a general farming area (Pennsylvania) but only to about $50 yearly per capita among Negro farm operators (South Carolina).

Accompanying these wide differences in income there are, of course, wide differences in the levels of living prevailing in these several areas. The opportunity for choice in consumption is greatly increased as purchasing power rises. Though farm families are less dependent on money income for livelihood than are urban dwellers, because of the opportunities for obtaining goods directly from the farm, there is a limit beyond which live-at-home programs should not be pushed in industrial economy.

In most areas studied, the farm-furnished food made considerable contribution to real income, averaging in value $250 or more per family. More than two-thirds of the families had their own eggs and poultry. Outside of California and the Southeast about two-thirds of them had their own milk. Except in California and the drought-stricken Middle West, half or more of the farms had potatoes and some other garden truck.

Farm-furnished food, providing as it does many of the protective foods which are costly to produce but even more costly to buy, helps to give farm families an advantage over urban dwellers when it comes to dietary adequacy. Three-fourths or more of the dietary records obtained from farm families in the North and West have been classified as grade A or "good" on the basis of their protein and mineral content; only 30 to 50 percent of the dietary records from village and city families in the same regions were equally satisfactory. In the South, diets of white farm families were better nutritionally than those of white families in southern villages and cities. Negro farm families had better diets than Negro village or city families.

Income variations within a single region are fully as great as between regions. In the wheat-farming sections of Kansas and North Dakota, for example, some families went in the red in 1935–36 while the total family incomes of others exceeded $4,000. About one-fifth of the families with positive incomes spent more for family living than they made, drawing on credit or savings for the difference. Expenditures for family living in this region ranged from about $600 in the lowest income brackets to almost $1,300 in the highest. With this doubling of expenditures for family living, the expenditures for each major item were also increased, but for some items far more than for others. This differential spending indicates to a certain extent the manner of living of different income groups. Average expenses for the family car were practically trebled when total expenditures doubled, and so were expenditures for recreation, formal education, as well as for gifts to persons outside the family, community welfare, and taxes. Average expenditures for clothing, personal care, and medical care doubled, whereas expenditures for food and household operation increased considerably less than 100 percent.

In most of the farm areas studied, the modal total income for nonrelief families was $750 to $999 in 1935–36. At this income level, farm families in Kansas and North Dakota spent an average of $723 for family living. Of this, $209 went for food to supplement what was home-produced (valued at approximately $300). The average total food supply was valued at about $115 per person yearly. Probably at least half of the families at this level were enjoying fully adequate diets. Clothing for the entire family cost scarcely $100. Fuel, light, ice, domestic help, and the incidental expenses of household operation took an average of $108, or about $15 out of every $100 spent.

In this group, medical service and medicines for all members of the family cost $59, and constituted the fifth largest item in the budget. This amount is nearer the $50 spent per family by the income group spending least for family living than to $100, the amount spent for this item by families in the highest income bracket.

Twenty-seven dollars was spent on recreation, and covered everything from Saturday-night movies at a nearby town to children's toys, purchase and repair of the radio, club dues, and sport equipment. About $7 was spent on books, magazines, and newspapers, and $8 on schoolbooks and other incidental expense of children's education. Personal taxes, gifts to persons outside the family, and contributions to community welfare amounted to $31 yearly.

These amounts are less than half of what was spent for these items by the more well-to-do families in the community.

So far the only analyses made of the data secured in small cities (8,000 to 15,000 in population) are those concerned with income and housing. Facts about expenditures will come later.

In most of the small cities in the North and West average incomes were between $1,200 and $1,600 yearly. In Westbrook, Maine, many families achieved higher-than-average incomes in 1935–36 through the pooling of earnings by several family members. Nearly one-third of all Westbrook families and almost half of those with incomes above the average (about $1,500 for the year) had more than one breadwinner. This finding of many families with several earners in Westbook, a manufacturing center, is in sharp contrast with the situation in Boone, Iowa, a trading center for an agricultural community, where only 1 out of every 10 families had more than one earner, and where the average family income was about $1,300. In Greeley, Colo., an educational and commercial center, average incomes were almost $1,600, in spite of the fact that more than three-fourths of the families had only one earner.

In Greenfield, Mass., about one-third of the families owned their homes and most of these were in the higher income brackets. Rentals paid averaged about $24 per month in this manufacturing city. In New Philadelphia, Ohio, where about half of the families owned their own homes, average rentals were only $14 monthly. Here close to 90 percent of the families lived in detached houses. In Westbrook, Maine, where rentals averaged $24 monthly, less than half of the families lived in detached, one-family houses. Over one-third lived in two-family dwellings, and the remainder in apartments and other types of living quarters.

The first broad view of village family expenditures for living is made possible by comparing figures from two diverse parts of the country—the Pacific coast and the Southeast. At each income level the proportions spent for food are about the same in the two regions, but in the Southeast more money is spent on clothing and household operation, especially household helps, and less on automobiles. On the Pacific coast the comparatively high expenditures for automobile purchase and upkeep suggest that travel is a preferred form of leisure-time activity. When village wage-earner families attain an income of $1,000 and when business and professional families reach $1,500, more is spent on the automobile than any major item except food; there is a greater increase in automobile expense as income rises than in expense for any other group of items.

Within a region expenditure patterns differ greatly from one income level to another. For example, a fivefold increase in total expenditures for family living by business and professional families in southeastern villages was accompanied by a sevenfold increase in expenditures for medical and personal care; a ninefold increase in expenditures for clothing; a tenfold increase in expenditures for reading and education; a seventeenfold increase for recreation; a twentyfold increase for the family car; and a twenty-sevenfold increase for gifts to persons outside the family, community welfare, and taxes. In contrast to these figures, expenditures for food increased only about fourfold and for household operation, only about threefold. These variable rates of increase in expenditures for various goods and services with rising total expenditures for family living throw some light on the extent to which needs and desires are met at the lower expenditure levels.

Impossible though it is to classify families into definite categories of "adequacy of living" by inspection of pay checks and ledgers of family expenses, nevertheless, expenditure patterns at different income levels do throw some light on the matter. There is little question, for example, that when even as much as 50 percent of a $600 income for a city family of five goes for food, the amount is still too little to insure adequate diets for every family member. And on such incomes little can be left, after meeting the most urgent requirements of physical maintenance for those items which enhance the human values of living.

Through this study of family expenditure patterns and of consumption habits it is hoped to develop objective criteria by which to evaluate the relative planes of living which family budgets afford under different conditions. For food, some scientific criteria already are available to assist in the evaluation of the nutritive qualities of diets. These are being applied to the data on food consumption secured from farm, village, and city families in the course of the study of consumer purchases.

ADEQUACY AND ECONOMY OF DIETS

During the year a study of the adequacy and economy of diets of employed city workers was completed. The results indicate that more money for food and a more effective application of present knowledge of food and nutrition to food selection are necessary if higher levels of nutrition are to be more generally attained by low-income city families.

The 3,500 dietary records from city families in different parts of the country on which this analysis was based were put at our disposal through the courtesy of the United States Bureau of Labor Statistics; statistical assistance was made available through the Works Progress Administration. The results of the study indicate that few families spending less than $1.50 per capita a week in 1935 obtained diets adequate for average health. The great majority of families spending $3.75 or more per capita a week were buying food in sufficient quantity and variety to provide high-grade diets. But whether good, fair, or poor diets were obtained by families spending between $1.50 and $3.75 weekly per capita depended on their food choices.

The quantity of food and the nutritive value of family diets increased with the amount spent for food. The market baskets of the low-expenditure families contained almost as much grain products, potatoes, and fats other than butter as those of high expenditures. Families spending more for food bought much more milk, butter, eggs, meats, and the succulent vegetables and fruits. Per capita consumption of these latter commodities often more than doubled between the lowest and highest expenditure groups. There were marked increases in per capita consumption of the so-called protective foods, milk, and green leafy vegetables as more money was spent for food. These foods supply the calcium and vitamin A which were found in inadequate quantities in many of the low-cost diets.

There are significant differences in the amounts spent for food by city wage-earning families in different parts of the country. More than one-third of the families in North Atlantic and Pacific coast cities were spending less than $2.50 per capita a week for food during 1935. So were two-thirds of the southern white and five-sixths of the southern Negro families. About one-fifth of the families in North Atlantic and Pacific coast cities were spending more than $3.75 per capita a week. Only 6 percent of the southern white and less than 3 percent of the Negro families were spending this much.

Many families spending between $2.50 and $5 per capita a week for food were found to be obtaining high-grade diets likely to promote good health and efficiency. Well over half of the families in the North Atlantic and Pacific coast cities but less than one-third of the southern families were spending this amount for food.

About one-fifth of the families studied in North Atlantic cities were obtaining food supplies affording only low-grade diets from the nutritive standpoint. One-eighth of the Pacific coast families, 40 percent of the southern white families, and 70 percent of the Negro families were on a low dietary level. The majority of these low-grade diets, however, were those of families spending less than $2.50 per capita a week for food.

Diets of families spending less than $2.50 per capita a week tended to provide smaller allowances of the minerals and vitamins than are considered necessary for good nutrition. The most common shortages seemed to be in calcium, iron, and vitamins A, B, and C.

Regional differences in the consumption of certain foods were more definitely marked among families on the lower expenditure levels than among those spending adequate or liberal amounts for food. North Atlantic families tend to buy more milk, butter, beef, lamb, and potatoes than do southern white families, but less of other vegetables and fruit, fewer eggs and poultry, less pork, and less flour. North Atlantic families buy more grain products than do Pacific coast families, more poultry, pork, and potatoes, but they buy less of other vegetables and fruits.

Racial background also makes a difference. White families in the South buy more eggs and milk but less meat and flour than Negro families in the same region spending comparable amounts for food. The country over, families spending a small amount of money for food use only a small quantity of milk. In the South, where expenditures for food are lower than in the North and West, milk consumption drops accordingly. But southern white families buy as much milk as white families in other regions when their food expenditures are the same. This puts a new light on the problem of milk consumption in the South.

In addition to this research now under way, data from other studies have been put into form for publication. A summary of family living in Knott County, Ky., is now in press. This depicts the effect upon the material conditions of family life of the farming of land much of which is below the margin of profitable cultivation. It was one of a series of studies made in cooperation with other agencies to afford a basis for the development of economic and educational policies in the southern Appalachian highlands.

Also work has proceeded in the formulation of guides to budgeting for low incomes, and in the preparation of material to assist housewives in buying food more wisely. Such information is particularly timely when many States are faced with the problem of defining, in connection with new minimum-wage legislation, what wages are necessary to provide "adequate maintenance and protection of health."

TEXTILES AND CLOTHING

The textile work has, as hitherto, been focused upon research related to the serviceability of fabrics in terms of consumer use and to the development of more adequate buying guides for household buyers.

DETERIORATION OF WOOL AND COTTON DURING USE

Results of a serviceability test on blankets made from four blends of wool have been published which report a cooperative study with the Bureau of Animal Industry comparing the serviceability of various combinations of fine, ½-blood, ⅜-blood, ¼-blood wool, and reworked wool.

The effect of three laundering procedures upon three of these blanket fabrics was also investigated and compared with the deterioration produced by wear plus laundering. In general, both repeated laundering alone and service plus washing caused a decrease in the strength index, air permeability, sulphur and nitrogen content, and the resistance to bacterial attack of the fabric, and an increase in weight per square yard, thickness, thread count, moisture and ash content, methylene blue absorption, and fiber scale breakage. However, every physical and every chemical test for measuring deterioration showed that wear plus laundering caused more damage than merely repeated laundering. This is significant in view of the fact that some laboratories are now judging the serviceability of fabrics by tests involving only repeated laundering. The amount of shrinkage of the blanket was found to be dependent on the fineness of the wool as well as on the laundry procedure.

Another cooperative study with the Bureau of Animal Industry on the use value of various qualities of American-grown wools has been started. Blankets were manufactured from good, ⅜-blood, Idaho wool combined with varying amounts of good and poor qualities of reworked wool. They were put into service in a Washington hospital. Samples will be withdrawn at regular intervals, and the deterioration measured chemically and physically.

A study of the deterioration of wool fabrics by micro-organisms is being undertaken cooperatively with the Division of Soil Microbiology of the Bureau of Plant Industry, and the initial report is in press.

In this investigation, a number of sterilizing methods were tested to determine the one most satisfactory for subsequent bacteriological studies on wool fabrics. The deterioration produced in a wool fabric by these sterilizing treatments was measured by strength index, weight, thickness, flexural properties, sulphur and nitrogen content, methylene blue absorption, and scale breakage.

It was found that ultraviolet light, potassium permanganate, iodine, alcohols, glycerol, tribrombetanaphthol, and tetrachlorethane did not give sterility under the conditions of the experiments. Although sodium phenylphenates prevented growth, they did not kill the organisms. Formaldehyde and mercuric salts gave sterility, but were retained by the wool and therefore made the fabrics unsuitable for subsequent bacteriological studies. Intermittent steaming and dry and wet autoclaving produced sterility but deteriorated the fabric to such an extent as to interfere with its serviceability. Heating in xylene, Stoddard solvent, or tetrachlorethylene gave satisfactory results from the bacteriological standpoint and also left the fabric essentially unchanged.

As an outgrowth of this investigation application has been made for three public service patents. These patents concern the sterilization of fibrous materials of animal origin by the use of heat combined with xylene, with Stoddard solvent, and with tetrachlorethylene.

A report covering the study of the serviceability of sheetings made from cottons grown under irrigated and nonirrigated conditions is being prepared. As measured by physical and chemical tests, the sheeting made from irrigated cotton was more deteriorated initially and throughout the service period than sheeting made from nonirrigated cotton or from a mixture of 20 percent of irrigated with nonirrigated. Fluidity measurements of cuprammonium hydroxide solutions of the cotton of the unlaundered sheets made each year for a period of 4 years show that chemical deterioration increased progressively with storage.

Through a cooperative arrangement with the Bureau of Agricultural Economics sheets have been made of Middling cotton of 14/16-, 15/16-, and 1-inch staple length. They are being used in a local hotel and washed in a commercial laundry. Sheets from each of the three lots will be analyzed after each 25 periods of wear and laundering.

The role played by micro-organisms in the deterioration of cotton fabrics is being investigated in cooperation with the Bureau of Plant Industry. A bleached and an unbleached cotton duck fabric have been inoculated with *Chaetomium globosum* and *Spirochaeta cytophaga*. The damage caused by these organisms is being estimated by measuring changes produced in the physical and chemical properties of the fabrics.

An annotated bibliography of references on the chemical testing of textiles was published in cooperation with the American Home Economics Association. It contains references to articles published in English, German, and French from 1920 to 1937, on qualitative and quantitative chemical methods of testing fibers and fabrics.

FINISHES FOR COTTON FABRICS

In order to get further information concerning the effect that starches and sizing mixtures produce on yarns and fabrics it was decided to study first the properties of dried films of starch independent of yarn and cloth. Therefore measurements of the pliability, stretch, and breaking strength of dried films of various starches used alone and when combined into sizing mixtures were obtained. Further tests were then made to relate this information to starch films applied to cloth.

These investigations were carried out on corn, wheat, rice, canna, dasheen, potato, and sweetpotato starches. Borax and glycerin in the proportions commonly used in sizing mixtures were added and their effects noted. A double-sulphonated castor oil and a neutral soap were also added to cornstarch. Because gelatin is often used as a sizing material the properties of its dried film were also measured.

The test for the pliability of starches involves holding a strip of film under definite tension and bending it back and forth around a curved surface until failure occurs. For all the starches the pliability decreases as the film thickness increases. The thicker the film the more brittle it becomes and the less folding it will stand. Canna starch films have the greatest pliability, potato films are next, then sweetpotato, corn, rice and wheat. Dasheen films are the least pliable. The gelatin film is more similar to canna starch film than to the other starches studied although it has considerably greater pliability. The addition of glycerin to a starch paste lowers its film pliability the least; then come, in order, the sulphonated castor oil, castile soap, and lastly borax. Borax makes starch films very brittle so that the films containing it fold very few times before breaking. The lowering of the pliability by glycerin, sulphonated castor oil, and castile soap is probably due to a softening of the film rather than to an increase in brittleness.

The breaking strength of starch films and the stretch at the breaking load were also obtained. The results show that all the starches get stronger as the film thickness increases. However, the increase in strength is greater for some starches than for others. At the average film thickness for each starch the potato-starch film is the strongest, canna is next, then sweetpotato, rice, corn, dasheen, and wheat. This same order was also maintained for the total elongation of each starch at its average thickness. In general small amounts of borax give greater strength to films than small amounts of glycerin but increasing amounts of borax greatly lower the breaking strength of films. Increasing amounts of glycerin produce little effect on strength of films, although the tendency is to weaken them. The addition of a sulphonated castor oil and a good grade of castile soap to starch pastes made the films stronger. Gelatin films are much stronger and stretch more than starch films.

The relationship between these various properties of dried films of starch pastes with the properties of starch films when applied to yarns and cloth was studied next. Measurements of stiffness, breaking strength, and elongation were made on fabrics sized with the various starches and sizing mixtures. Because stiffness affects the resistance of a fabric to bending it is interesting that these stiffness results compare very well with the pliability (or folding endurance) results obtained for the starch films. Favorable comparison may also be made between these cloth-strength results and the film-strength results. Further analysis and comparisons are being made and a detailed report is being prepared.

QUALITY GUIDES FOR PURCHASERS OF CLOTHING AND HOUSEHOLD TEXTILES

As an outgrowth of the laboratory analysis and service tests on cotton and wool fabrics, buying guides for consumer use have been prepared on sheets, blankets, and bath towels. A classification of sheetings into five groups with a minimum specification for each has been proposed as an aid to household buyers in judging quality.

Various types of upholstery have been purchased and analyzed. These data will be used as a basis for proposing minimum specifications which will serve as a purchasing guide for two grades of friezes, damasks (including brocades), and rib weaves.

A similar study on the qualities of cotton broadcloth is in progress. This is a part of the work on the development of definitions for fabrics carried forward in cooperation with the American Society for Testing Materials.

The earlier contributions on fabrics and designs for children's clothes have been brought up to date and prepared for publication under one cover. This new bulletin will meet the many requests of nursery-school directors and child-welfare clinics for information on children's clothing in line with modern ideas of child hygiene and habit training. Commercial patterns are available for six of the designs illustrated.

A set of nine charts dealing with the principles of clothing selection has been issued for use by extension workers and leaders of adult-education groups and placed on sale by the Superintendent of Documents.

The consumer buying helps have been in great demand. Twelve photographic folios are on continuous loan schedules. These suggest points to look for in selecting various items of clothing and household textiles. The most recent folio deals with women's hosiery.

In cooperation with the Extension Service, exhibits of clothes for 4–H club girls and of household textile items were prepared for use in the judging contests which are a part of the National 4–H Club Congress held in Chicago each year. Since then the exhibit of clothes has been circulated to State 4–H club leaders who requested it for use in their State programs. A new 4–H club girl's uniform was designed and cooperation was given to the two commercial companies who made the patterns. In addition to the 4–H club exhibit, two traveling exhibits of children's clothing and one of clothes made from used materials have been maintained and circulated. During the year, 60 loans of these exhibits were made. This service has been used by 42 States, Alaska, and the District of Columbia, and many additional requests could not be accommodated.

The study of the labeling of textiles and clothing as one means of supplying consumers with guidance in textile selection has been continued. Posters showing current labels are lent to study groups, and special displays are prepared as needed for cooperation with retailer-distributor meetings.

GARMENT AND PATTERN SIZES

Under an allotment from the Emergency Relief Appropriation of 1937 and through the cooperation of the Works Progress Administration and the National Youth Administration, the Bureau has been enabled to initiate a study of the body measurements needed as a basis for children's garment and pattern sizes.

This study is under way in eight States and the District of Columbia, in cooperation with the following institutions: University of Alabama; Institute of Child Welfare of the University of California; Iowa Child Welfare Research Station of the State University of Iowa, working with the Iowa State College of Agriculture and Mechanic Arts; Kansas State College of Agriculture and Applied Science; University of Minnesota; Pennsylvania State College; and Agricultural Experiment Station of Texas, working with the Texas Technological College. The Bureau is in direct charge of the work in the District of Columbia and in Maryland.

As is also true in the case of clothing for adults, heretofore no scientific study has been made of the measurements of children, as a basis for sizing clothing and garment patterns. As a result, the proportions used today for ready-made clothing and for patterns are not uniform, and in many cases little relation exists between the dimensions used and human measurements. The age sizes marked on children's garments very rarely correspond with the dimensions of children of that age. The lack of any scientifically determined body measurements which can be used as a standard has also made possible the practice of skimping on the size of garments in order to meet competitive prices. This has added to the confusion until today it is almost impossible to purchase a child's garment satisfactory in size without taking the child to the store to be individually fitted.

Each State institution cooperating in the project has appointed a State director to arrange for measurements to be taken within that State. Scientifically trained persons work under the supervision of these directors. A manual of procedures to be followed has been prepared and instruments calibrated by the National Bureau of Standards are supplied. Thirty-six measurements determined in consultation with garment distributors and manufacturers, are being taken on each child. An effort is being made to measure 100,000 children over a wide geographic area. These will be representative of both sexes, two economic levels, and age groups from 2 to 14 years.

The measurements are taken by squads composed of persons trained in the technique to be followed and assisted by workers from the Works Progress Administration and the National Youth Administration. The consistency of the results is determined by duplicate measurements which are taken from time to time; also by checkers sent out from headquarters to insure that all workers are adhering to the same standards of procedure.

HOUSING AND HOUSEHOLD EQUIPMENT

As a background for improvement of rural housing, a summary of data collected from 46 States as a Civil Works Administration project are being prepared for publication. Help was obtained from the Works Progress Administration in the preparation of the statistical summaries. Also in cooperation with the Oregon State College of Agriculture, a study has been made of special requirements of rural housing in different sections of the country. This material should be of value to architects and builders as well as extension workers, teachers, and rural homemakers.

A conference was called of representatives from six State experiment stations working in the field of household equipment for the purpose of planning experimental studies cooperatively so that the greatest amount of information can be made available in the shortest period of time. This group outlined a series of publications on household equipment into which Federal and State contributions will dovetail.

The study of different fuels used for cooking, initiated in cooperation with the Bureau of Agricultural Engineering, was continued and the cooking tests have been completed. Bottled gas, gasoline, kerosene, manufactured gas, and electricity were the fuels studied. Two typical ranges were used in each case except with the gasoline, which was tested in only one range. The data are being analyzed to determine which results were due to the particular design of the stove and which to the fuel.

Based on the total consumption of heat energy required in cooking 6 days' meals, electricity proved to be the most efficient. In terms of energy units bottled gas used 1.78, kerosene 1.82, manufactured gas 2.02, and gasoline 2.91 times as much as electricity for the same cooking. Menus of three cost levels were used—liberal, moderate, and low cost. Comparing them on the basis of cost of cooking, the moderate-priced meals for 2 days cost 1.16 times as much to cook as the low-priced meals, and the liberal meals 1.18 times as much as the low-priced meals. Summing up the time required for the individual cooking processes in each meal, on the average the moderate-priced meals took 1.32 times and the liberal meals 1.15 times the period required for preparing the low-cost foods in these particular menus. In planning menus for families of restricted income, these figures may be useful as a rough indication of the relative importance of the time required and fuel cost of the cooking.

The section on equipment in the bulletin on home laundering has been revised and enlarged to cover the newer kinds of electric equipment particularly. The revised bulletin is now in press.

Continuing the work previously begun, no-load tests of four more household refrigerators have been made. The results of these few tests agree with the statement commonly made that more recent models use considerably less electrical energy than did the models of a few years ago.

An accelerated life test was carried out for four refrigerators. Two ice-cooled cabinets and two electric refrigerators which had been tested when new were then operated for 90 days in a room at about 100° F. and 85 percent relative humidity. The manufacturers usually take the cabinets apart immediately after this 90-day period in order to find the weak points and thus improve their product. The aim here was to examine the effect of such a period on the overall performance of the units; hence they were retested according to the original method. One ice-cooled refrigerator maintained about the same average temperature but melted about 4 percent more ice. In the other the average temperature rose about 1°, while the ice-melting rate increased about 7 percent. Because of absorption of moisture by the insulation the cabinets gained in weight about 6 and 19 pounds, respectively. One of the electric refrigerators showed no change in efficiency, while the other model showed definitely poorer performance. However, several months later this model was again retested and appeared to have returned to its original state. This type of test needs more study before such results can be interpreted in terms of the useful life of the refrigerator.

PUBLICATIONS AND INFORMATION SERVICES

With the addition of the new bulletins issued this year or now in press, the list available to homemakers and consumers from the Bureau totals 35. These are popular interpretations of basic research, as distinguished from the technical publications for the use of scientists. These consumer bulletins deal with practical problems in diet planning, food values, and meal preparation. They translate the findings of the textile chemists into guides for selecting and caring for household fabrics and clothing so as to get full service value. They deal with kitchen planning and choice of household equipment.

The technical contributions form another group. They are issued as bulletins in small editions for distribution to research workers or for deposit in libraries. Progress reports are also contributed to scientific journals.

The following list of new material issued during the past fiscal year includes both types of publications, grouped as contributions to the regular series of the Department, and as articles in outside journals:

DEPARTMENT PUBLICATIONS

Diets to fit the family income. By R. S. Carpenter and H. K. Stiebeling. Farmers' Bull. 1757.

Home canning of fruits, vegetables, and meats. By Louise Stanley and M. C. Stienbarger. Farmers' Bull. 1762.

Guides for buying sheets, blankets, bath towels. By B. M. Viemont, M. B. Hays, and Ruth O'Brien. Farmers' Bull. 1765.

Homemade bread, cake, and pastry. By F. B. King and A. B. Freeman. Farmers' Bull. 1775.

Fabrics and designs for children's clothes. By C. L. Scott and Margaret Smith. Farmers' Bull. 1778. (In press.)

Quality guides in buying women's cloth coats. By C. L. Scott. Leaflet 117.

When disaster cuts down home-grown food. Unnumbered. (In cooperation with Extension Service and Resettlement Administration, U. S. Department of Agriculture, and Children's Bureau, U. S. Department of Labor.)

Menus and recipes for lunches at school. By R. S. Carpenter, H. N. Hann, and F. W. Yeatman. Misc. Pub. 246.

Clothing selection charts. Set of nine black and white charts, each 20 by 30 inches; 40 cents from the Government Printing Office.

Vitamin content of foods. A summary of the chemistry of vitamins, units of measurement, quantitative aspects in human nutrition, and occurrence in foods. By E. P. Daniel and H. M. Munsell. Misc. Pub. 275.

Toxicity of food containing selenium as shown by its effect on the rat. By H. E. Munsell, G. M. DeVaney, and M. H. Kennedy. Tech. Bull. 534.

A serviceability test on blankets made from four blends of wool. By M. B. Hays, R. E. Elmquist, and J. I. Hardy. (In cooperation with Bureau of Animal Industry.) Tech. Bull. 572.

Family living in Knott County, Ky. By F. M. Williams, H. K. Stiebeling, I. G. Swisher, and G. S. Weiss. Tech. Bull. 576. (In press.)

ARTICLES IN OUTSIDE JOURNALS

Relative vitamin C content of orange and tomato juices determined chemically and biologically. By E. P. Daniel, M. H. Kennedy, and H. E. Munsell. Jour. Home Econ. 28: 470–474. September 1936.

Effect of home canning and storage on ascorbic acid content of tomatoes. By E. P. Daniel and M. B. Rutherford. Food Research 1 (4): 341–347. July–August 1936.

Ascorbic acid content of a number of citrus fruits. By E. P. Daniel and M. B. Rutherford. Jour. Agr. Research 54: 689–693. May 1, 1937.

Contribution to data on the composition of some of the more common vegetables. By Rosemary Loughlin. Jour. Home Econ. 29: 255–257. April 1937.

Grading of eggs and poultry important to consumers. By Louise Stanley. U. S. Egg and Poultry Mag. 42: 607, 626, 628, 630, illus. October 1936.

Choose your fruits and vegetables for their food value. By Louise Stanley. Life and Health 51 (8): 14, 25, 26–27, illus. August 1936.

Cake-making quality of eggs as related to some factors in egg production. By F. B. King, E. F. Whiteman, and W. G. Rose. Cereal Chem. 13: 703–711. November 1936.

The relative value of various lards and other fats for deep-fat frying of potato chips. By F. B. King, Rosemary Loughlin, R. W. Riemenschneider, and N. R. Ellis. (In cooperation with Bureau of Animal Industry.) Jour. Agr. Research 53: 369–381, illus. September 1, 1936.

The relation of degree of finish in cattle to production and meat flavors [factors]. By G. A. Branaman, O. G. Hankins, and L. M. Alexander. (In cooperation with Michigan State College and Bureau of Animal Industry.) Amer. Soc. Anim. Prod. Proc., November 27–28, 1936.

The influence of retarded growth in lambs on flavor and other characteristics of the meat. By N. G. Barbella, O. G. Hankins, and L. M. Alexander. (In cooperation with Bureau of Animal Industry.) Amer. Soc. Anim. Prod. Proc., November 27–28, 1936.

Report of the U. S. Department of Agriculture bread flavor committee. By F. B. King, D. A. Coleman, and J. A. LeClerc. (In cooperation with Bureau of Agricultural Economics and Bureau of Chemistry and Soils.) Cereal Chem. 14 (1): 49–58. January 1937.

Some international considerations of the food problem. By H. K. Stiebeling. Jour. Home Econ. 28: 653–656. December 1936.

Food consumption of urban and village families at different levels of food expenditure. By H. K. Stiebeling. Jour. Home Econ. 29: 6–10. January 1937.

Income regulates the diet. By H. K. Stiebeling. U. S. Bur. Agr. Econ. Agr. Situation 21 (6): 19–21. June 1, 1937.

Textile work in the Bureau of Home Economics. By Ruth O'Brien. Tex-Style 2 (2): 12–13, illus. November 1936.

Hosiery standards. By Ruth O'Brien. Jour. Home Econ. 28: 605–606. November 1936.

Strength produced in different fabrics by various starches and modified starches. By M. S. Furry. Jour. Home Econ. 28: 687–690. December 1936.

Ironing as a factor in the deterioration of cotton fabrics. By R. E. Elmquist, and K. M. Downey. Rayon Textile Monthly 17 (12), 68–70, 74, illus. December 1936; 18 (1): 81–83, 84, illus. January 1937; (2): 51–53, illus. February 1937.

Classification of sheets as an aid to consumer buying. By M. B. Hays. Rayon Textile Monthly 18 (3): 71–72, illus. March 1937.

Progress reports have also been given to the public through press and radio channels.

Preliminary releases giving the results of the consumer purchasing study in small cities, towns, and rural areas—the part of this survey for which the Bureau assumed responsibility—have been going to the press for the last 3 months. These reports covering separate geographical units will be followed by regional summaries as more figures become available, and eventually by interpretative articles calling attention to significant trends in American family-spending habits.

The scope of the weekly Market Basket press release has been altered to fit new economic trends. Started during the depression to aid families in selecting nutritionally adequate diets at the lowest possible cost, it has become an established weekly feature in the metropolitan and rural press. Through this medium the consumer gets news of foods in particular abundance and of special value from the nutritive standpoint, together with suggestions on preparing and serving them so as to retain their important food values.

Active participation has continued in broadcasting talks on radio networks with a Nation-wide coverage. About 150 such talks on network programs have been given by members of the staff during the 12-month period. In addition approximately 200 radio scripts have been vised for syndicating to local stations by the Radio Service of the Department.

The response from these bulletins, radio programs, and releases is an index of the widespread desire on the part of the public for scientific guides to the practical problems of everyday living.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - Price 5 cents

REPORT OF THE DIRECTOR OF INFORMATION, 1937

United States Department of Agriculture,
Office of Information,
Washington, D. C., October 6, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I submit herewith a report of the work of the Office of Information for the fiscal year ended June 30, 1937.

Sincerely yours,

M. S. Eisenhower,
Director of Information.

Until about 1910 technical knowledge of production was mainly what farmers wanted from the Department. Therefore the information services of the Department specially emphasized production research and combined the recommendations of technical specialists in diverse lines for practical application by the farmers. In addition, the Department furnished crop and market news and necessary information concerning the administration of regulatory laws, such as the Food and Drugs Act.

Subsequently, when it became evident that production was catching up with demand, farmers felt that the obvious benefits of production science should be supplemented with marketing science and information. As marketing and other studies developed, the information work of the Department broadened; it interpreted and correlated data in the production and economic fields. Economic information helped farmers to plan their crop planting and livestock breeding.

After the World War and the economic crisis of 1929 farmers required even more than production and marketing science and the information based thereon. A wholly new situation necessitated numerous action programs, based upon scientific and economic information, for the purpose of dealing with production and marketing together, as the two halves of a single problem, and for helping farmers to adjust all their operations to the changing physical and economic environment. Necessarily, the character of the agricultural information disseminated by the Department changed.

Under the cooperative leadership of the Department of Agriculture and of the State agricultural institutions farmers became more interested in conservation. Forest and wildlife conservation, which had commanded attention for many years, appeared now as phases of a many-sided problem that included the land in farms as well as the land not in farms. The conservation of soil rose to a position of paramount importance. Two developments coincided: The demand for crop adjustments, based upon economic and scientific facts, and a national interest in soil conservation. They were parts of the same thing. Farmers realized that a conservational use should replace an exploitive use of the land, as an indispensable safeguard against the physical and economic disorganization of the farming industry. The Department responded with action to combat the wastage of the Nation's water, soil, vegetative, and human resources. Nearly every bureau of the Department contributed to these programs, which were designed to promote stability in farm income and a good rural-urban balance, wise use and conservation of natural resources, security of farm tenure, efficient low-cost production, efficient distribution, and a higher standard of rural life.

As required by the act of Congress that created it, the Department endeavors to disseminate agricultural information in the most comprehensive and general sense. This undertaking has become much more complicated in recent years. Farmers want information as much as they ever did about improving crops and animals, controlling pests, safeguarding food supplies, and trends in demand and prices. They want much other information besides, such as facts about physical, economic, and social conditions, and also interpretations of these facts, in terms adapted to their use in production, marketing, and soil conservation. Farmers want to know the productivity

of their soil, the degree of its erosion, and the land-use methods that will control erosion. They want to know how zoning regulations, soil conservation districts, and changes in tax-delinquency laws can help them. In the so-called problem areas, such as the southern Great Plains, and to some extent in all areas, farmers are asking for data and interpretations which apply not only to individual farms but to entire regions. They are coming to realize that the welfare of the individual farmer depends upon the willingness and ability of thousands of farmers to cooperate in good land-use practices, and in other means of stabilizing agriculture. Also, they want the facts on which national agricultural programs must be based.

The Department has met these new needs fairly well. It needs to do more, however, and to develop better methods. More information for dissemination in visual forms (models and maps, for example) on physical and economic conditions, would be effective, particularly on soil, erosion, and land-use problems. Cheaper processes of reproducing such visual means of education are required. More publications that simply and clearly synthesize information about the physical, economic, and social conditions in given areas must be prepared and issued. Rural discussion groups, a development of the last few years, must have more material suited to their needs. The shift from exploitive to conservational farming, and the acute need for special adjustments in the problem areas, call for new methods of gathering, synthesizing, interpreting, and disseminating information.

NEW ACTIVITIES

The transfer of the Resettlement Administration to the Department on January 1, 1937, increased the responsibilities and broadened the task of the information staff, notably in connection with rural rehabilitation and the development of a land-utilization program. Congress enacted the Bankhead-Jones Farm Tenant Act to relieve and progressively to eliminate the worst forms of tenancy, and also to promote rural rehabilitation, proper land utilization, and the retirement from agriculture of land that is submarginal for farming. The Resettlement Administration then appropriately became the Farm Security Administration, with responsibility among other things for the tenancy and rehabilitation programs. To the Bureau of Agricultural Economics was assigned the task of developing a land-utilization program including the retirement of submarginal land. Land-use planning activities should be integrated with farm management, research, and service, so that the total bearing of all the important economic forces and factors can be kept in view. It is a function of the information services to present a balanced picture of the situation, in a manner suited to the requirements of the action programs. Considerable progress was made in this direction during the year, but much correlation of the work, particularly in the field activities, remained to be done.

The Omnibus Flood Control Act of 1936 has had an unexpectedly great effect on the agricultural information work. It recognizes the War Department's responsibility for the improvement of rivers and waterways, and makes the Department of Agriculture responsible for watershed investigations and measures for run-off and water-flow retardation, and for the prevention of soil erosion on certain specified watersheds. The Department long ago stressed the influence of forests on flood control; subsequently, it sought to interest farmers in methods of reducing the water run-off and of controlling erosion. The new Flood Control Act broadened the task. It necessitated bringing together the foresters, the agronomists, the soils men, the soil conservationists, and the economists in the formulation of land-use programs applicable to entire watersheds. Nothing less will suffice, if land treatment is to make its proper contribution to the reduction of flood hazards. Wise land use helps to solve a primary water problem, and makes for a sound and permanent agriculture. Information activities are indispensable. The complete analysis of watershed problems, in highly specific detail, is beginning to make necessary facts available. Next will come the double task of recommending particular land-use practices, and of presenting a complete picture of the principal necessary adjustments and of indicating what flood control through land treatment and soil conservation can acomplish. Mainly it can do five things: (1) Save soil for grazing, farming, and forestry; (2) eliminate what would otherwise be recurring minor floods; (3) reduce the volume of major floods; (4) reduce the sedimentation of reservoirs; and (5) reduce the silting of stream channels.

Twenty-two States have adopted soil-conservation districts legislation, partly to cooperate with the Department under the Flood Control Act and partly to participate more widely in soil-conservation work. As farmers organize effectively to deal with land problems locally, they will require all the information on specific physical and economic conditions that the Department and the State agricultural colleges can supply. They will want assistance from all branches of the Department. This is one of the reasons the Department recently established an Office of Land Use Coordination, with a flood control coordinating committee as a part thereof, to coordinate the land-policy, land-survey, and land-use planning activities of the Department. In the field, regional coordinating committees have been set up to bring the necessary facts together in the flood-control program, and in one region—the "dust bowl"—a field coordinator has been designated to correlate all action programs in that area. These developments are simply indicative of the new requirements in extending agricultural service to farmers. Field information work will have to be modified to meet these new conditions.

CONSUMER INFORMATION

Other branches of the Department's informational work have been well maintained, particularly those of special interest to consumers. As everyone is a consumer, all citizens of the country are benefited in one way or another by the work of the Department. Material issued by radio, through the press, and in official publications aids consumers to obtain goods suited to their needs, safeguards their health, helps them to plan diets in accordance with their incomes, to produce and preserve vegetables and fruits, and in general to improve their homes and home surroundings.

COMMODITY INFORMATION

The Department has varied sources of information about particular commodities, and the Office of Information helps to coordinate the diverse facts. Research on each commodity is specialized in the various bureaus, but farmers and others want the data correlated. They cannot apply isolated facts in producing, marketing, and processing. Commodity information must be comprehensive or it is not usable. So that it may be made comprehensive, the information staff must be strengthened, and recommendations have been made for an increase of the staff. Commodity writers would specialize in cotton, wheat, small grains, corn and hogs, tobacco, livestock and poultry, dairying, and fruits and vegetables.

CORRELATION OF INFORMATION IN THE FIELD

Scientific, regulatory, conservation, and other information that originates in Washington is effectively coordinated, but this is not equally true of information that originates in the field. Additional cooperation with State extension editors was effected during the year to give the press and radio stations all the essential agricultural information from the fewest possible sources and without duplication. The Soil Conservation Service, during the year, in its 11 regional headquarters, released information practically entirely in cooperation with the extension editors. The field staff in rehabilitation and land-utilization work also cooperated extensively with extension editors. But conditions in the field and the needs of farmers have changed so greatly in recent years that new means of coordinating information that originates in the various regions will have to be devised.

EXPENDITURES

Printing and binding expenditures for the year amounted to $854,250. This included $258,137 for administrative forms and binding; $199,876 for reports, regulatory notices, periodicals and other administrative publications; $175,975 for technical publications; and $220,262 for popular publications. The expenditures for salaries and expenses were $357,720. Of this amount, only $57,400 was for writers and editors. The balance was for distribution, photographic, illustrating, duplicating, mailing, and related services.

DIVISION OF PUBLICATIONS

New and revised publications issued during the past year made available to farmers and others the results of the Department's research, regulatory, service, and conservation programs. Notable among these were a number of new bulle-

tins giving farmers much needed information on practices designed to conserve soil and water, including Cover Crops for Soil Conservation; The Use of Bluegrass Sod in the Control of Soil Erosion; Soil Defense in the Piedmont; Preventing Soil Blowing on the Southern Great Plains; and Strip Cropping for Soil Conservation. These publications, several of which were prepared by writers in cooperation with specialists rather than by scientists, were attractive as well as effective bulletins.

A number of bulletins intended primarily for homemakers were issued. Among these were such bulletins as Diets to Fit the Family Income; Home Canning of Fruits, Vegetables, and Meats; Guides for Buying Sheets, Blankets, and Bath Towels; and Homemade Bread, Cake, and Pastry.

The Bureau of Agricultural Economics made many improvements in its publications. The form of The Agricultural Situation was improved; it is now sent to crop reporters in place of Crops and Markets which was previously mailed to them. The annual outlook report was simplified, shortened, and made more readable. This was supplemented by a popular bulletin entitled "The Farmer Looks Ahead", to give farmers the necessary background for a critical view of the longer range possibilities in agriculture. In addition commodity situation reports were developed to keep the annual outlook report up to date month by month.

In 1937 the second volume of the genetics Yearbook was issued. It continues the treatment of the comprehensive subject of the improvement of plants and animals through the science of genetics which was started in the 1936 edition. The new-style Yearbook has met with such great favor among both technical workers and farmers that the plan is being continued for the 1938 Yearbook, which will be devoted to soils, and for the 1939 Yearbook, which will be devoted to nutrition.

Further improvements were made during the year to make the publications of the Department more useful and to publish the accumulation of data more economically with a limited appropriation for printing. Efforts were made to present data as briefly as possible and to devise economical methods for publishing information without sacrificing the primary objective of using publications for bringing to readers complete, reliable, and understandable information. One improvement, somewhat experimental in nature, consisted of a single sheet, printed on both sides, one showing in color and describing a species of harmful insect, and the other detailing control measures which may be successfully applied by the farmer.

The complete list of new bulletins issued during the year follows:

Farmers' Bulletins:
- 1757. Diets to Fit the Family Income.
- 1758. Cover Crops for Soil Conservation.
- 1759. Game Management on the Farm.
- 1760. The Use of Bluegrass Sod in the Control of Soil Erosion.
- 1761. Harvesting with Combines.
- 1762. Home Canning of Fruits, Vegetables, and Meats.
- 1763. Harvesting and Handling Citrus Fruits in the Gulf States.
- 1764. Growing and Feeding Grain Sorghums.
- 1765. Guides for Buying Sheets, Blankets, and Bath Towels.
- 1766. Game Laws for the Season 1936–37.
- 1767. Soil Defense in the Piedmont.
- 1768. Trapping and Transplanting Live Beavers.
- 1769. Dairy Cattle Judging.
- 1770. High-Grade Timothy and Clover Hay.
- 1771. Preventing Soil Blowing on the Southern Great Plains.
- 1772. Use of Concrete on the Farm.
- 1774. The Farmer Looks Ahead.
- 1775. Homemade Bread, Cake, and Pastry.
- 1776. Strip Cropping for Soil Conservation.

Leaflets:
- 117. Quality Guides in Buying Women's Cloth Coats.
- 118. Controlling Lungworms of Swine.
- 119. White Clover.
- 120. Excluding Birds from Reservoirs and Fishponds.
- 121. The Sweetpotato Weevil and How to Control it.
- 122. United States Graded and Stamped Meat.
- 123. The Farmers' Share of the Consumer's Food Dollar.

Miscellaneous Publications:
- 228. Market Diseases of Fruits and Vegetables: Peaches, Plums, Cherries, and Other Stone Fruits.
- 237. Food Plants of the North American Indians.
- 238. Directory of Activities of the Bureau of Plant Industry.
- 240. Colloid Chemistry of Cellulosic Materials.
- 241. The Genera of Parasitic Wasps of the Braconid Subfamily Euphorinae with a Review of the Nearctic Species.
- 243. Manual of the Grasses of the West Indies.
- 244. Officials and Organizations Concerned with Wildlife Protection, 1936.
- 246. Menus and Recipes for Lunches at School.

Miscellaneous Publications—Continued
247. Forestry and Permanent Prosperity.
248. Peat Land in the Pacific Coast States in Relation to Land and Water Resources.
250. Tests of Woods for Butter Containers with Reference to Imparting Odor and Flavor.
252. List of Publications of the United States Department of Agriculture from January 1931 to December 1935, Inclusive.
253. Conservation Farming Practices and Flood Control.
254. Workers in Subjects Pertaining to Agriculture in Land-Grant Colleges and Experiment Stations, 1936–37.
255. The Farm Outlook for 1937.
256. Early Erosion-Control Practices in Virginia.
259. Comparison of Various Chemical Quick Tests on Different Soils.
260. A Graphic Summary of Physical Features and Land Utilization in the United States.
261. A Graphic Summary of Farm Tenure (Based largely on the Census of 1930 and 1935).
262. A Graphic Summary of Farm Taxation.
270. Post-Mortem Examinations of Wild Birds and Mammals.
277. List of Sires Proved in Dairy Herd Improvement Associations 1935–37.

Circulars:
390. Flour-Mill Insects and Their Control.
392. Diagnosing Bee Diseases in the Apiary.
393. Care and Maintenance of Cotton-Gin Saws and Ribs.
394. Dimension-Stock Methods for New England Hardwoods.
398. Measuring Fire Weather and Forest Inflammability.
399. Machine Placement of Fertilizers for Snap Beans in Florida.
400. A Simple Method for Detecting Mastitis Streptococci in Milk.
401. Control of the Japanese Beetle and its Grub in Home Yards.
402. Blue Grama Grass for Erosion Control and Range Reseeding in the Great Plains and a Method of Obtaining Seed in Large Lots.
403. Preventing Injury from Japanese and Asiatic Beetle Larvae to Turf in Parks and other large Areas.
404. The Choice of Crops for Saline Land.
405. Susceptibility of Grape Rootstocks to Root Knot Nematode.
406. Oil Burners for Home Heating.
407. Plowing as a Means of Destroying Wireworm Pupae in the Pacific Northwest.
408. Wireworm-Infestation Trends Accompanying Certain Crop Rotations in the Pacific Northwest.
409. The Effect of Thallium on Plant Growth.
410. Results from Breeding Rabbits that are Suckling Young.
411. A Study of Arsenical Dusting of Cabbage in Relation to Poison Residues.
412. Groups of Plants Valuable for Wildlife Utilization and Erosion Control.
413. An Improved Method for Converting an Observed Skein Strength of Cotton Yarn to the Strength of a Specified Yarn Count.
414. Farmer Bankruptcies, 1898–1935.
415. Equipment for Applying Dust Fungicides to Seed Grain.
416. Land-Improvement Measures in Relation to a Possible Control of the Beet Leafhopper and Curly Top.
417. The Farm Real Estate Situation, 1935–36.
418. Parasites and Predators of the Mexican Bean Beetle in the United States.
419. The Fir Engraver Beetle, a Serious Enemy of White Fir and Red Fir.
420. The Houma Potato: A New Variety.
421. Results of Field Crop, Shelterbelt, and Orchard Investigations at the United States Dry Land Field Station, Ardmore, S. Dak., 1911–32.
422. Biology of the Tobacco Moth and Its Control in Closed Storage.
423. The House Rat.
424. Distribution of the Varieties and Classes of Wheat in the United States in 1934.
425. A Method for the Control of Cotton Root Rot in the Irrigated Southwest.
426. Use of Soil-Moisture and Fruit-Growth Records for Checking Irrigation Practices in Citrus Orchards.
427. Peach Mosaic, its Identification and Control.
428. Flight Speed of Birds.
429. The Rhododendron Whitefly and Its Control.
430. Emergency Wind-Erosion Control.
431. Increasing Growth and Yield of Young Spruce Pulpwood Stands by Girdling Hardwoods.
432. Country Milk-Receiving and Cooling Stations.
440. The Tomato Pinworm.
441. Development of Powdery Mildew Resistant Cantaloup No. 45.

Technical Bulletins:
506. Identification, History, and Distribution of Common Sorghum Varieties.
508. Effect of Artificially Drying Seed Cotton Before Ginning on Certain Quality Elements of the Lint and Seed and on the Operation of the Gin Stand.
511. Timber Growing and Logging Practice in Ponderosa Pine in the Northwest.
515. The Effect of Crazy Top Disorder on Cotton Plants and Its Control by Irrigation Management.
518. A Second Revision of the Chalcid Flies of the Genus *Harmolita* (Isosoma) of America North of Mexico, with Descriptions of 20 New Species.
520. Temperature Studies of Some Tomato Pathogens.
521. Agricultural Loans of Commercial Banks.
522. Incomplete Milking in Relation to Milk Production and Udder Troubles in Dairy Cows.
523. Transportation of Apples from the Shenandoah-Cumberland Section to Overseas Markets.
524. Silting of Reservoirs.
525. Handling, Precooling, and Transportation of Florida Strawberries.
526. Flow of Water Around 180-Degree Bends.
527. Progressive Effects of Polyporus Versicolor on the Physical and Chemical Properties of Red Gum Sapwood.

Technical Bulletins—Continued

528. Conditions Influencing Erosion on the Boise River Watershed.
529. Effect of Different Methods of Wintering Beef Calves, in the Northern Great Plains, on Winter Gains and Feed Costs and on Subsequent Summer Gains.
530. Selenium Occurrence in Certain Soils in the United States with a Discussion of Related Topics, Second Report.
531. Bud Selections in Eureka and Lisbon Lemons and Progeny Tests of Bud Variations.
532. The Comparative Moisture-Absorbing and Moisture Retaining Capacities of Peat and Soil Mixtures.
533. Subsoil Waters of Newlands (Nev.) Field Station.
534. Toxicity of Food Containing Selenium as Shown by Its Effect on the Rat.
535. Wheat Requirements in Europe.
536. Crop Rotation and Tillage Experiments at the Northern Great Plains Field Station, Mandan, N. Dak.
537. Growth of Douglas Fir Trees of Known Seed Source.
538. Effect of Method and Rate of Grazing on Beef Production and Plant Population of Pastures at Beltsville, Md.
539. Federal Seed-Loan Financing and Its Relation to Agricultural Rehabilitation and Land Use.
540. Fungi Isolated from Discolored Rice Kernels.
541. Deterioration of Book and Record Papers.
542. Neutralization Curves of the Colloids of Soils Representative of the Great Soil Groups.
543. Blast-Furnace Processes for the Production of Phosphatic and Potassic Fertilizer Materials.
544. Yield of Even-Aged Stands of Sitka Spruce and Western Hemlock.
545. Methods for the Measurement of Certain Character Properties of Raw Cotton.
546. Structure, Occurrence, and Properties of Compression Wood.
547. Effect of Different Methods of Grazing on Native Vegetation and Gains of Steers in Northern Great Plains.
548. Control of Southern Celery Mosaic in Florida by Removing Weeds that Serve as Sources of Mosaic Infection.
549. Drought Survival of Native Grass Species in the Central and Southern Great Plains, 1935.
550. Protection of Apples and Pears in Transit from the Pacific Northwest during the Winter Months.
551. Forest Fire Insurance in the Pacific Coast States.
552. Trace Elements in the Soils from the Erosion Experiment Stations, with Supplementary Data on Other Soils.
553. Effect of Temperature, Humidity, and other Factors on Hatch of Hens' Eggs and on Energy Metabolism of Chick Embryos.
554. Rapid Determination of Oil Content and Oil Quality in Flaxseed
555. Marketing Onions.
556. Soil Conservation Reconnaissance Survey of the Southern Great Plains Wind-Erosion Area.
558. Soil and Water Conservation Investigations at Soil Conservation Experiment Station Missouri Valley Loess Region, Clarinda, Iowa. Progress Report 1931–35.
559. Influence of Packing and Handling Methods on Condition of Apples Barreled for Export.
560. Yield, Stand, and Volume Tables for Even-Aged Upland Oak Forests.
561. The Effectiveness of Cultivation as a Control for the Corn Earworm.
563. Incidence and Development of Apple Scab on Fruit During the Late Summer and While in Storage.
564. Comparison of Feeds for Fattening Beef Calves Before and After Weaning.
565. Comparison of Feeds for Wintering Steers in the Northern Great Plains.
566. Western Hemlock Bark, an Important Potential Tanning Material.
567. Soil Erosion and Stream Flow on Range and Forest Lands of the Upper Rio Grande Watershed in Relation to Land Resources and Human Welfare.
568. Seed Treatment Experiments with Oats Naturally and Artificially Inoculated with Smuts.
570. Decay in Merchantable Oak, Yellow Poplar, and Basswood in the Appalachian Region.
571. Irrigated Crop Rotations at the Huntley (Mont.) Field Station, 1912–35.
572. A Serviceability Test on Blankets made from Four Blends of Wool.

DUPLICATED MATERIAL

In addition to editing, printing, and distributing the publications of the Department, the Division of Publications handles thousands of requests for information that come from the public, and maintains a duplicating plant for the issuance of administrative and ephemeral material.

Duplicating processes, such as the mimeograph, multigraph, and multilith, are much cheaper than printing. But a decision of the Acting Comptroller General makes mandatory the printing of many forms and other material regardless of whether they could be duplicated more economically. There are, of course, many jobs which may legally be duplicated. During the year the Department urgently recommended that the printing laws be amended in the light of the great improvements made in duplicating equipment, for although it is striving faithfully to adhere to present laws and decisions, there are many "border-line" jobs that are difficult to classify. Though distinctly inferior to printing, the duplication of considerable material of an administrative or ephemeral nature is satisfactory and inexpensive, and may be done on short notice.

Carefully following the line of reasoning laid down by the Acting Comptroller General, the Department during the past year duplicated a total of 106,862,339 pages, of which about 20 percent was for the Agricultural Adjustment Administration.

MATERIAL IN OUTSIDE PUBLICATIONS

Approximately 1,850 articles prepared by Department workers and published by nongovernmental journals were handled by the Division of Publications during the year. Separates of 202 of these were purchased for official use, inasmuch as Federal publications on the technical subjects covered were not available. Though the Department finds publication of its material in outside journals useful, this is by no means a substitute for official publication. Usually the technical journals cannot publish scientific material in sufficiently comprehensive form, the Department can buy but few copies to meet urgent requests for information on its own scientific work, and the needs of libraries are not met.

DISTRIBUTION OF INFORMATION

During the year the Office of Information received hundreds of thousands of requests for information. In the interest of speed and economy, these were filled with appropriate bulletins whenever possible, the distribution staff determining the proper bulletins to send. At the present time the Office is operating under handicaps because the turn-over of personnel in the distribution section is excessive. It is exceedingly important that requests for information coming from the public and through Members of Congress be handled accurately and speedily. Long experience and training in the work make this possible and steps are being taken by the Office to strengthen the section and thereby improve the service.

STATISTICAL DATA

The Division of Publications received 1,351 manuscripts for publication during the year. Requisitions from the bureaus for photographic and drafting work totaled 10,147, and the amount of work done included 204,461 photographic and 2,840 drafting items. During the year 5,277 requisitions were drawn on the Government Printing Office for manuscripts and job work as compared with 5,022 for 1936. The number of mailing lists was reduced from 1,058 to 990 but the number of names on the lists increased by 105,629 to a total of 707,629. Detailed data showing the distribution of the Department publications during the year are shown in table 1.

TABLE 1.—*Report of publications received and distributed by the Office of Information, Department of Agriculture, from July 1, 1936, to June 30, 1937*

Item	Copies on hand July 1, 1936	Copies of new publications received	Copies of reprints or revisions received	Total copies available for distribution during year	Copies distributed during year	Copies on hand June 30, 1937
Agricultural Situation		860, 800		860, 800	860, 800	
Annual reports	11, 806	55, 025		66, 831	58, 602	8, 229
Atlas American Agriculture	4, 979	3, 198		8, 177	4, 879	3, 298
Circulars	411, 060	273, 000	129, 000	813, 060	348, 011	465, 049
Climatological Data		7, 655		7, 655	7, 655	
Climatological Data (section summary)		55, 000		55, 000	55, 000	
Clip Sheet		397, 500		397, 500	397, 500	
Crops and Markets		1, 365, 100		1, 365, 100	1, 365, 100	
Department bulletins	31, 931		13, 000	44, 931	22, 492	22, 439
Department circulars	13, 848		38, 500	52, 348	20, 941	31, 407
Experiment Station bulletins and reports	111	4, 250	1, 000	5, 361	5, 237	124
Experiment Station Record		82, 550		82, 550	82, 550	
Extension Service Review		136, 400		136, 400	136, 400	
Farmers' bulletins	6, 543, 550	910, 000	9, 858, 600	17, 312, 150	8, 238, 400	9, 073, 750
Farmers' bulletin lists	1, 013, 800		2, 333, 000	3, 346, 800	3, 160, 500	186, 300
Forest Service recreational folders		35, 000		35, 000	35, 000	
Indexes	9, 804	66, 740		76, 544	67, 017	9, 527
Inventories of Seeds and Plants Imported		1, 500		1, 500	1, 500	
Journal of Agricultural Research		45, 000		45, 000	45, 000	
Journal of Agricultural Research separates		85, 250		85, 250	85, 250	
Leaflets	1, 121, 415	140, 000	1, 530, 000	2, 791, 415	1, 106, 692	1, 684, 723
Miscellaneous circulars	43, 568		14, 000	57, 568	16, 678	40, 890

TABLE 1.—*Report of publications received and distributed by the Office of Information, Department of Agriculture, from July 1, 1936, to June 30, 1937*—Con.

Item	Copies on hand July 1, 1936	Copies of new publications received	Copies of reprints or revisions received	Total copies available for distribution during year	Copies distributed during year	Copies on hand June 30, 1937
Miscellaneous publications	317, 651	498, 200	252, 200	1, 068, 051	666, 808	401, 243
Monthly List of Publications		175, 650		175, 650	175, 650	
Monthly Weather Review		18, 000		18, 000	18, 000	
Monthly Weather Review separates		14, 875		14, 875	14, 875	
North American Fauna	728	3, 500		4, 228	3, 490	738
Posters	154, 874	207, 100	242, 750	604, 724	334, 336	270, 388
Public Roads		57, 950		57, 950	57, 950	
Service and Regulatory Announcements	116, 436	886, 850	83, 800	1, 087, 086	982, 666	104, 420
Soil Conservation		52, 000		52, 000	52, 000	
Soil Surveys	55, 325	45, 600	1, 089	102, 014	26, 760	75, 254
Statistical bulletins	11, 558	20, 500		32, 058	13, 162	18, 896
Statistics		13, 000		13, 000	12, 921	79
Technical bulletins	158, 530	263, 300	27, 000	448, 830	235, 328	213, 502
Unnumbered publications	874, 902	1, 575, 209	1, 059, 000	3, 509, 111	1, 675, 209	1, 833, 902
Weekly Weather Crop Report and Snow and Ice Bulletins		270, 900		270, 900	270, 900	
Yearbooks	505	15, 000		15, 505	11, 658	3, 847
Yearbook separates	79, 118	34, 300	3, 000	116, 418	23, 224	93, 194
Total	10, 975, 499	8, 675, 902	15, 585, 939	35, 237, 340	20, 696, 141	14, 541, 199

PRESS SERVICE

Much information obtained by the Department depends for its value to the public on prompt distribution. Accordingly, through its Press Service, the Department issues releases on important developments in the crop and livestock markets at home and abroad, on weather conditions that affect agriculture and other interests, on plant and animal quarantines imposed or removed, on pest outbreaks or invasions, on administrative rulings under various regulatory laws, on developments in action programs, and on farm prices and farm incomes. News about such things has real value, and reaches all parts of the United States soon after the Department's Press Service makes it available.

The Press Service confines its releases to material of timely and practical value. A release containing estimates of the probable farm income for 1937, for the country as a whole and for particular commodities, for example, is "must copy" in every newspaper, because it provides a basis for important decisions, not only in agriculture but in business, manufacturing, and banking. A release about the addition of new areas to the district quarantined near New York on account of Dutch-elm disease is important to editors and readers in that area. When Congress passed an act amending the so-called cotton grade and staple law, the Department issued a press release indicating how farmers may use the measure in cotton-improvement programs, and pointed out that the law enables farmers who grow premium cotton to bargain on the basis of the actual value of their product, and provides a stimulus to one-variety cotton communities. These are typical samples of informational material which must be issued promptly and disseminated widely to be of greatest value.

Another important function of the Press Service, which perhaps no other agency could fulfill, is the preparation and dissemination of agricultural research results. In preparing articles on research the Press Service has the cooperation of the Department's bureaus. Findings in all branches of agricultural science can be shown in usable form in combination with pertinent economic and social data. Newspaper reporters could seldom explore research so fully. They might do so occasionally on matters of exceptional interest; the Department's Press Service does it as a routine procedure with every release. It submits each article to critical review in all the bureaus that may be interested. This method insures accuracy, comprehensiveness, and proper coordination of various kinds of knowledge.

Collaboration among many specialists may be necessary in the preparation of a single article. Material issued after the floods in the Ohio drainage basin last spring provides an example. Specialists in the Soil Conservation Service, the Forest Service, and the Bureau of Agricultural Economics provided the information for an article on land treatment for flood control which concentrated research results representing the scientific labor of many years. Through contacts with all branches of the Department, the Press Service can present

authoritatively and quickly, in a balanced combination, the facts necessary for action on different problems.

In the Department's work, publication lags behind research. Many useful findings reach the public through official publications only after a long delay. Material distributed to the press and to magazines partly overcomes this lag, and provides an important supplement to the Department's own publications. Research findings reach the farmers and the public through these channels more quickly, though much less comprehensively, than they do through the slower processes of official publication.

Competition among public-service agencies, State and Federal, for newspaper space has become a fairly acute problem. Naturally, only information which the Department feels is wanted by readers is distributed, and it is presented in a form most acceptable to editors and readers. For example, many of the economic reports of the Department are now prepared with a news summary, and all releases are made as brief as possible. Nevertheless, the volume of material issued by all public agencies is a problem that must be met constructively. The Department can best work out the agricultural phase of this with the State extension editors in order that the most significant agricultural information may reach editors in usable form and quantity.

The press associations and some of the larger newspapers now have staff writers assigned to the Department. In addition many correspondents regularly visit the Press Service, which facilitates their work by arranging for interviews with scientists, economists, and others. The Department is today probably the most thoroughly "covered" agricultural agency in the world, an indication of the public interest in all phases of farm improvement.

Increasing interest in economic and conservation information has not lessened the demand for results of research. The Department Yearbooks for 1936 and 1937 received wide praise in the press, and many extracts have been reprinted. The yearbooks have also provided the basis for many individual articles on genetics—a science not widely understood. Short popular releases on the practical application of genetics in plant and animal improvement were used as widely during the year as economic information was a decade ago. The 1936 and 1937 Yearbooks promise to be the foundation of widespread popular education through all branches of the press.

Weather news continues to be front-page news. Droughts and floods brought many requests for information, particularly for information on what the Government was doing and individuals could do to alleviate bad conditions. Current weather reports were of unusual interest. This in turn led to more interest in releases on weather research, including research designed to give better service to aviation.

IMPROVEMENT IN MAILING LISTS

The Department adds names to its press mailing lists only upon request. These lists are classified by subjects. Thus a release on livestock may be sent only to general livestock papers or to livestock marketing papers. Another release may be sent only to poultry papers, another only to papers interested in swine, and so on. In all, the Press Service has 119 classified lists.

Lists of daily and weekly newspapers are broken down by States so that releases may be sent only to those States where they are of most interest. As a further refinement in distribution, the Press Service, in cooperation with the Agricultural Adjustment Administration, is classifying these lists by counties, and segregating them according to commodity interests. When this is completed it will be possible to send releases on wheat, for example, only to newspapers in counties where wheat is of major interest.

COOPERATION WITH COLLEGE EDITORS

One of the most significant changes in press work is the trend toward localization. As a supplement to its regular services direct to the press, the Press Service prepares special releases for exclusive distribution by the State agricultural extension editors, who adapt the information to local conditions.

The Homemaker News Service, which was developed just before the beginning of the 1937 fiscal year, consists of about three stories a week on home economics subjects, sent to extension editors. After adding any facts available at the State office, the editor may distribute the stories directly to the press in his State or he may send them to county home demonstration agents for further localizing and release.

A general agricultural service, similar to the Homemaker News Service. was started during the year. It covers most of the activities of the Department.

Spot news is handled by issuing regular releases as in the past, but follow-up stories, or those giving definite recommendations arising from Department research, are now prepared for exclusive handling by extension editors. Releases on current economic factors affecting the outlook for farm commodities have been especially popular in this new series. The cooperation of extension editors in handling this special service has been excellent. Many of the editors supply copy for farm pages in daily newspapers as well as a regular service to the weeklies of their States. Others give county agents an opportunity further to localize the stories before release. If the new service continues to meet the needs of extension editors and local papers it will largely displace direct mailing to weekly newspapers from Washington.

The use of an increasing number of pictures in the press has been accompanied by a large increase in the number of requests that come to the Department for photographs. In the past year the Department has been called upon many times to provide sets of related photographs for use in picture strips. It has cooperated with the illustrated magazines in obtaining pictures that tell the story of Department activities. Photographs are today one of the most effective and most popular informational techniques. More than 600 were supplied to writers and editors upon request.

Illustrated press releases continue to meet with approval. As pointed out in previous reports, this type of release is particularly adapted to economic charts, weather maps, and diagrams of various mechanical devices.

During the year, the Press Service issued 1,463 releases and distributed 319 releases for the Agricultural Adjustment Adminstration.

RADIO SERVICE

During the year radio broadcasting became more useful than ever before in disseminating agricultural information. Reliable trade estimates placed at 79 percent the proportion of all American homes containing radio-receiving sets on January 1, 1937. The trade estimates were not broken down to give figures for farms and cities. From 1928 to 1936 farm ownership of receiving sets lagged behind city ownership. In 1936 farm incomes came up markedly and the proportion of radio-equipped farm homes began to approximate the proportion of city homes so equipped. The trade estimates that 1,065,000 receiving sets were sold to farmers in 1936 and that farm sales will amount to 1,200,000 in 1937. Trade authorities forecast that by January 1, 1938, probably 60 percent of the farm homes and 83 to 84 percent of all homes will be equipped with radio-receiving equipment.

The Radio Service, acting as the liaison unit between all branches of the Department and the operators of radio networks and individual stations, arranges for the transmission of information regarding the parts of the Department's work which are of greatest importance to the greatest number of citizens and which are best adapted to reporting by radio.

In the network programs open to the Department during the past year, the National and Western Farm and Home Hours, special emphasis was placed upon (1) the series of 19 talks by the Secretary of Agriculture in which he discussed the most pressing problems of agriculture in 1937 and advanced suggestions looking toward the solution of these problems; (2) 3 reports each week on the current activities in the programs carried on under the Soil Conservation and Domestic Allotment Act and the Agricultural Adjustment Act, and twice a week, on the average, summaries of the findings of the Department's economists concerning different phases of the current or prospective agricultural situation; (3) the series of 8 programs supporting the discussion-group movement—a series which introduced this year for the first time broadcasts by actual farmer discussion groups, and by leaders of opinion not connected with the Department of Agriculture, since the series was presented under the auspices jointly of the American Association of Land-Grant Colleges and Universities and the Department of Agriculture; (4) the series of 5 round-table conference broadcasts by Department officers explaining the program of operation under the Omnibus Flood Control Act; and (5) the series of 17 talks by and interviews with the editor and associate editor of the 1936 Yearbook of Agriculture, summing up in popular form the statements of progress in various lines of genetic investigations contained in the Year book.

Along with these specially planned series, the Department issued in the network broadcasts a variety of current farm business and science information. Special attention also was paid to information for homemakers. The special broadcasts by the Consumers' Counsel of the Agricultural Adjustment Admin-

istration in cooperation with the General Federation of Women's Clubs also continued.

In the syndicate programs issued by the radio service, for broadcast through individual stations, the emphasis was similar to that in the network programs. However, the syndicate programs, being more highly regionalized than the network programs, carried a considerably greater volume of reports of results of research which found application on farms and in homes within relatively small areas.

In total, the Radio Service in consultation with all branches of the Department, sent out for reception in American homes equipped with receiving sets from 15 to 30 minutes of information daily reflecting the progress made in the action programs in behalf of agriculture, the results of scientific and economic research carried on to reveal information that would be useful to farmers and homemakers, the management of the forests, bird and animal refuges, and other public property in the open country for which such units of the Depatment as the Forest Service and the Bureau of Biological Survey act as public trustees; and work done in connection with the enforcement by Department units of Federal regulatory acts.

The Department does not operate any transmitters under the general Federal policy with respect to radio broadcasting. The Congress appropriates no funds for the purpose of hiring the use of transmitting facilities. Therefore, this Department and other Government departments seek and accept the cooperation of individual radio licensees and the network organizations sending out programs for broadcast by individual licensees. Maintenance of cooperative arrangements with the officers of individual stations and with the managements of the networks is as important a Radio Service function as that of choosing the subject matter for, preparing, and producing the programs. At the end of the fiscal year we had in force the following arrangements for broadcasting facilities to carry programs from the Department:

(1) The Department, at the invitation of the National Broadcasting Co., had available from 15 to 20 minutes daily within the National Farm and Home Hour broadcast at 12:30 to 1:30 p. m., eastern standard time, by 70 stations affiliated with the blue network of the National Broadcasting Co. The company produced the full hour program which included entertainment provided by the company and information provided by the Department and other agricultural agencies invited by the company to broadcast within the hour. The National Farm and Home Hour is broadcast daily from Monday to Friday inclusive. At the same hour on Saturdays the National Broadcasting Co. invites national farm organizations to present programs. The Department of Agriculture has no connection with and no control over the Saturday programs except for the one presented on the first Saturday of each month by the 4–H Clubs. The 4–H Club program is arranged and presented by the Department in cooperation with State extension services.

(2) The Department broadcasts daily from Monday to Friday, inclusive, in the Western Farm and Home Hour a program similar to that presented in the National Farm and Home Hour under arrangements identical with those existing for the National Farm and Home Hour. The National Broadcasting Co. presents the 1-hour program (from 11:30 a. m. to 12:30 p. m., Pacific standard time) providing entertainment features to fill half or more of the time and inviting the Department and other agricultural agencies to present information features in the remainder of the time. The Department period runs from 15 to 20 minutes daily. At the close of the fiscal year 15 stations affiliated with the blue network of the National Broadcasting Co. were broadcasting the Western Farm and Home Hour.

(3) The National Broadcasting Co. has invited the General Federation of Women's Clubs to present a consumers' program in the afternoon red network schedules, and the federation has requested the Consumers' Counsel of the Agricultural Adjustment Administration to be responsible for preparation and particularly for presentation of consumer information from Department of Agriculture sources. The Consumers' Council has for 4 years cooperated in this program. The Radio Service has given general supervision to the preparation of the broadcasts and more than half the time has provided the voices to produce them. This program is currently broadcast at 1:30 p. m., eastern standard time. The National Broadcasting Co. offers it to all stations in the red network, but it is uncertain how many of them are transmitting it.

(4) From time to time network organizations or individual stations request the Department to arrange broadcasts of information dealing with specific agricultural situations of an emergency nature or general social significance. Most of the requests of this sort during the year were made in connection

with reporting the drought situation in the summer of 1936. The Radio Service arranged four such broadcasts for the Columbia Broadcasting System and three for the National Broadcasting Co.

(5) To provide information to the audiences of cooperating individual stations the Radio Service maintains a system of daily 7-minute Farm Flash releases. In 39 States these releases go from the Radio Service to the State extension editors who combine them with information available in the State and send them on either to the stations to be presented by announcers or to county agents who present these programs, plus more completely localized information.

Late in the year we obtained reports on the use of the Department Farm Flash releases. In the 39 States where we send them to the extension editors, they were reported broadcast by 192 stations on varying schedules. At 59 of these stations the Farm Flashes are presented by county agents once a week or more frequently, and 25 stations report county agent programs separate from the Farm Flash programs. In the 9 States where the Farm Flashes are sent direct to stations they are reported broadcast by 66 stations. On only 3 of these stations are the county agents taking part in the programs, although 16 stations report separate county agent programs. In total, the reports indicated that the Farm Flashes are broadcast by 268 stations, at 62 of the stations by county agents; that there are all together 121 stations in the country where county agents from 1 or more counties now present information programs.

(6) The Department sends a daily 7-minute Housekeepers' Chat release carrying information for consumers and homemakers to 243 stations which late in the year reported broadcasting the releases.

At the request of the Agricultural Adjustment Administration we experimented with the transcription form of releasing agricultural information in March. A 10-minute transcribed talk by the Administrator was sent to stations presenting the Farm Flashes. All of them broadcast the transscription. Reports on its quality were contradictory, some reporting it very unsatisfactory, others very satisfactory. The experiment indicated that the use of the transcription method was too expensive to undertake at the present time on a regular schedule.

The radio committee of the American Association of Agricultural College Editors has surveyed the position of the joint Federal-State programs for broadcast through cooperating individual stations and has recommended that the State extension services strengthen their staffs for preparing and producing radio programs in order to serve the radio-equipped farm and city homes with broadcasts of useful information attractively presented. The committee also recommends that county agents and members of farm families be encouraged to take more part in presenting these information programs. The Radio Service concurs in these recommendations. At the request of the Agricultural Adjustment Administration we joined with the Office of Cooperative Extension Work in recommending wider farmer participation in local radio broadcasts last April. The response has been encouraging.

The radio committee of the Editors' Association noted also complaints by a third of the editors reporting that they could not get schedules adapted to reaching farm listeners with any assurance that they would be continued for a time long enough to justify these editors in rearranging their work and adding personnel to produce good broadcasts. This also is a limiting factor in the usefulness of radio in the Department experience. The indicated line of future development is to strengthen our provisions for preparing and producing public service programs and at the same time to seek better cooperative arrangements with the radio licensees.

It is important that we continue to deal directly with the licensees. With the increase in number and proportion of radio-equipped farm homes and in the incomes of farmers, advertisers have been turning to the broadcasts developed by the Department and the State extension services as possible bases for advertising programs. The Department policy must be to ask the radio licensees to deal with us directly and to continue to accept the responsibility of deciding whether or not the Department will be allowed to broadcast within the existing American radio system.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - Price 5 cents

REPORT OF THE LIBRARIAN, 1937

UNITED STATES DEPARTMENT OF AGRICULTURE,
LIBRARY,
Washington, D. C., September 15, 1937.

HON. HENRY A. WALLACE,
Seretary of Agriculture.

DEAR MR. SECRETARY: I submit herewith the report of the library for the fiscal year ended June 30, 1937.

Sincerely yours,

CLARIBEL R. BARNETT, *Librarian.*

CONTENTS

As the Department Library consists of the main Library and the branch libraries in the various bureaus and divisions, the following report of the Library's work during the year is based on the manuscript reports submitted by the heads of the divisions of the main Library and the reports of the branch libraries in the various bureaus. The four divisions of the main Library are the Catalog Division, the Periodical Division, the Readers' Division, and the office of the Librarian which attends to the business, personnel, and general administrative work.

ACQUISITIONS

The acquisition work of the Library is divided between the Catalog Division, the Periodical Division, and the office of the Librarian. The Chief of the Catalog Division has charge of the work connected with the acquisition of books and the Chief of the Periodical Division, of periodicals and other serials. The library accountant in the office of the Librarian attends to the preparation of the orders and keeps all of the purchase records and the records of payments. The administrative assistant to the Librarian has charge of the foreign exchange lists.

The number of cataloged accessions for the fiscal year compared with those received in the fiscal year 1936 is shown in table 1.

24691—37

TABLE 1.—*Accessions to the Library, fiscal years 1936 and 1937*

Item	1936	1937
Purchases:		
Volumes	2,015	2,485
Pamphlets	125	270
Maps (and charts)	35	15
Serials	280	292
Continuations	403	474
Total	2,858	3,536
Gifts and exchanges:		
Volumes	1,777	1,965
Pamphlets	1,436	1,404
Maps (and charts)	69	48
Continuations	4,404	5,129
Total	7,686	8,546
Bindery continuations	3,127	1,607
Volumes laced in binders	736	988
Current entries	269	261
Total	4,132	2,856
Grand total	14,676	14,938

The amount spent for books, periodicals, and serials was approximately $4,000 more than in the previous year, which was made possible by an increase in the Library appropriation, but even with this increase the funds for the purchase of books and periodicals were exhausted 2 months before the end of the year. Because of the Library's limited funds, the only additions worthy of special note which have been made during the year to the collection of old and rare books and important series are a copy of J. J. R. Hübner's, Beiträge zur Geschichte der Schmetterlinge, 2 volumes in 1, 1786–90; a copy of Joannes Jonstonus' Historiæ Naturalis de Quadrupedibus Libri, 1657; and a complete set of the work of the Ökonomische Gesellschaft des Kantons Bern, entitled "Memoires et Observations Recueillies," 14 volumes in 21, 1760–73, generally referred to as the first periodical on rural economy. Mention should perhaps also be made of a film copy of a rare pamphlet entitled "Elenchus Plantarum Horti Botanici Monspeliensis," Anno 1804, by P. M. A. Broussonet, which was made from a copy of the original in the British Museum. A photoprint of the film copy was later made by the Bibliofilm Service. The pamphlet was needed in connection with certain investigations of the Bureau of Plant Industry.

About three-fourths of the books, pamphlets, and continuations received during the year, aside from the bindery accessions, were received as gifts and exchanges. Grateful acknowledgment is made to all of the institutions, societies, firms, and "friends of the library" in this country and abroad who have kindly contributed to the Library's resources. The Library is also indebted to the various bureaus which have presented to it a number of books purchased from their funds. Agricultural Adjustment Administration presented 18 purchased from its funds; Bureau of Agricultural Economics, 9; Bureau of Chemistry and Soils, 18; Bureau of Entomology and Plant Quarantine, 146; and Soil Conservation Service, 317. The total of these gifts from the bureaus was 508, as compared with a total of 472 in the fiscal year 1936. Transfers from the Copyright Division, Library of Congress, numbered only 34.

On July 1, the Library contained 272,696 accessioned volumes and pamphlets. The actual number, however, is believed to be fully 300,000, since the Library contains many thousands of periodicals, pamphlets, bulletins, and reports in temporary binders which have not been accessioned.

EXCHANGES

In connection with the work of obtaining foreign exchanges, lists are maintained of foreign institutions, societies, and officials to whom publications of the Department are sent in exchange. A regulation of the Department (No. 1375) provides that exchanges for Department publications be addressed to the Library.

In addition to the sending of publications to the regular mailing lists, the Library issues orders on the Division of Publications for the mailing of miscellaneous Department publications which are specifically requested. The number of such orders made for the year was 1,248, an increase of 161 compared with the fiscal year 1936.

CATALOG DIVISION

The Catalog Division (Helen M. Thompson, Chief) reports that while the figures giving the number of volumes, pamphlets, continuations, maps, and charts cataloged during the year show a slight increase compared with the figures for the previous year, the number of uncataloged items at the end of the year was much larger, being 8,600, compared with 5,763 in 1936. These figures are exclusive of an uncataloged collection in the less well-known foreign languages which has been accumlating for several years because of the difficulty in cataloging them. The arrears in cataloging are due to insufficient help for this work. A contributory cause in connection with the cataloging of Department and other Government publications has been the change in form in entering them which has made much extra work. This change was inaugurated last year at the request of the card section of the Library of Congress. It has proved a considerable sacrifice of our own good to the larger good of cooperation. Full statistics regarding the cataloging, including the cards added to the main catalog and to the various catalogs and indexes maintained by the branch libraries in the bureaus and divisions, are given in tables 2 to 4. The total number of cards contained in the general catalog of the main Library is now approximately 1 million, and in the branch libraries, approximately 3 million. In the case of the branch libraries, the 3 million cards are principally index entries for periodical articles.

TABLE 2.—*Material cataloged, fiscal years 1936 and 1937*

Item	1936	1937
Volumes	3,792	4,450
Pamphlets	1,561	1,674
Maps and charts	104	63
Continuations and serials	5,087	5,895
Total	10,544	12,082
Bindery continuations	3,127	1,607
Volumes in binders	42	109
Additions to binders	736	988
Current entries	269	261
Changed titles	89	100
Closed entries		75
Total	4,263	3,140
Grand total	14,807	15,222
Pamphlets cataloged (by author only)	101	66
Reprints (reprint collection)	36	27

TABLE 3.—*Cards in the Agr series prepared for printing, and cards received, fiscal years 1936 and 1937*

Item	1936	1937	Item	1936	1937
Cards sent to be printed:			Printed cards received:		
Accessions	307	367	Accessions	327	344
Department publications	342	594	Department publications	473	596
Agricultural periodicals	44	124	Agricultural periodicals	93	123
Total	693	1,085	Total	893	1,063

TABLE 4.—*Cards added to various catalogs and indexes, fiscal years 1936 and 1937*

Library	Cards added		Cards withdrawn		Net increase	
	1936	1937	1936	1937	1936	1937
Main Library	26,033	28,104	4,332	4,083	21,701	24,021
Agricultural Economics	23,061	18,533				
Division of Cotton Marketing	2,850	4,072				
Special index	2,561	2,947				
Agricultural Engineering	2,311	2,560				
Special indexes		4,722				
Animal Industry	11,003	6,563		3,142		3,421
Animal Husbandry Division	505	675				
Dairy Industry	1,679	1,366				
Special indexes	152	330				
Entomology and Plant Quarantine	3,743	2,191				
Special indexes	12,310	12,578				
Division of Bee Culture	1,000	850				
Experiment Stations	3,796	5,480				
Special indexes	12,215	11,055				
Forest Service	20,000	16,500				
Home Economics	931	915				
Plant Industry	60,037	60,702				
Special indexes	4,275	1,939				
Public Roads	3,930	3,061	400		3,530	
Special indexes	12,500	16,000				
Soil Conservation Service		3,471				
Special indexes		1,619				

PERIODICAL DIVISION

The Periodical Division (Lydia K. Wilkins, Chief) reports that the new plan for displaying the current periodicals, which was inaugurated at the close of the fiscal year 1936, is meeting with success. The current issues are kept for 1 week on the display cases in the periodical reading room. A regular examination of these display cases once a week on the same day of the week (morning or afternoon) makes it possible to see practically all of the periodicals received by the Library with the exception of certain statistical and economic journals which are sent direct to the Bureau of Agricultural Economics library, where they are on display in the reading room of that library on the third floor, just above the main Library. The plan was definitely inaugurated as an experiment. The use made of the service during the year has been sufficient to justify its continuance. As it becomes better known its use, it is believed, will increase.

Statistics regarding the number of periodicals and newspapers received currently during the year, compared with the number received in the fiscal years 1935 and 1936, are given in table 5.

TABLE 5.—*Periodicals and newspapers currently received, fiscal years 1935, 1936, and 1937*

Item	1935	1936	1937
Different periodicals received by purchase	1,384	1,390	1,461
Different periodicals received by gift and exchange	3,109	3,280	3,350
Total	4,493	4,670	4,811
Duplicate periodicals purchased	347	297	327
Duplicate periodicals received by gift and exchange	390	450	500
Total	737	747	827
Total periodicals received	5,230	5,417	5,638
Average number of periodicals received daily	275		
Different dailies received	174	176	197
Extra copies received	47	42	64
Total dailies received	221	218	261
Farm bureau publications currently received	177	184	173

No separate record has been kept in the Periodical Division of the number of continuations (annual reports, transactions, bulletins of irregular issue, etc.) received, but the records of the Catalog Division show that 5,895 were cataloged during the year, compared with 5,087 in 1936. The number of serials waiting to be cataloged at the close of the year was 3,160 compared with 1,774 in 1936 and 450 in 1935. Because of the increasing arrears in the cataloging of serials and the difficulty in getting additional help for the cataloging work, it is feared that the Library will in the near future be obliged to discontinue entering the new issues of serials in its main catalog and to depend for the most part on the Continuation List, maintained in the Periodical Division, for information regarding the latest issues of serials in the Library. Before this plan even can be carried out, however, much work will be required in marking the catalog cards in some way to indicate to readers and library assistants where the information regarding later issues can be found. It will be regretted if this makeshift arrangement becomes necessary for it is a great saving of time in the reference and loan-desk work to have in the main catalog complete information regarding the Library's holdings.

During the year much time was required on the part of the assistant chief of the Periodical Division in connection with the proofreading of the List of Periodicals Currently Received in the Library on June 1, 1936, and in the preparation of the subject index to the list. The List, which was published as Miscellaneous Publication No. 245 of the Department, is greatly facilitating the use of the periodicals in the Department.

BINDING

The binding section of the Periodical Division (in charge of Joseph J. Canavin, under the general supervision of Elizabeth G. Hopper, assistant chief of the Division) has had a difficult year as it was unfortunately necessary not infrequently to detail one of its assistants to the current periodical section for several weeks at a time. The amount of the binding was therefore less than in the previous year. This was not due entirely to lack of assistance but also to lack of binding funds. Additional funds for binding and an additional assistant, whose full time can be devoted to the bindery work, are urgently needed. The statistics regarding the binding work for the last 5 years are given in table 6.

TABLE 6.—*Binding work done for the Library, fiscal years 1933–37*

Item	1933	1934	1935	1936	1937
Books and periodicals sent to bindery	5,715	7,895	5,121	5,206	4,966
Volumes laced in temporary binders	2,725	2,329	1,913	1,865	1,149
Total	8,440	10,224	7,034	7,071	6,115
Current serials added to binders	1,088	954	617	783	822

READERS' DIVISION

The Readers' Division (Emma B. Hawks, associate librarian, in charge) reports an increase in the reference use of the Library and in the circulation. The combined statistics of circulation in the main Library and the bureau libraries are given in table 7. As in previous years, it is necessary to point out that these figures indicate only approximately the use of the Library, a record of the circulation of books and periodicals not being kept in all of the bureau libraries and no record of the reference use being kept in any of the libraries.

TABLE 7.—*Combined statistics of circulation, 1936 and 1937*

Bureau or office library	Books circulated— To individuals		To Library		To branch libraries		Total		Current periodical circulation		Borrowers in 1937
	1936	1937	1936	1937	1936	1937	1936	1937	1936	1937	
Main Library	27,516	30,772	------	------	32,554	33,198	60,070	63,970	(1)	[2] 110,000	------
Agricultural Economics	22,928	20,872	1,087	1,275	291	1,219	24,306	23,366	(1)	88,383	944
Division of Cotton Marketing	4,871	4,182	(1)	(1)	(1)	(1)	4,871	4,182	25,300	34,312	55
Agricultural Engineering	3,898	3,842	342	491	152	------	4,392	4,333	12,555	13,100	204
Animal Industry	4,163	4,167	276	282	68	58	4,507	4,507	45,756	43,498	98
Animal Husbandry	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	12,240	14,345	84
Chemistry and Soils	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	20,000	44,293	(3)
Fertilizer Investigations	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	2,306	2,306	85
Dairy Industry	1,549	1,735	106	119	97	57	1,752	1,911	29,912	28,631	78
Entomology and Plant Quarantine	4,012	4,530	517	667	1	------	4,530	5,197	19,883	21,975	177
Division of Bee Culture	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	------
Experiment Stations	2,032	2,522	(1)	(1)	(1)	(1)	2,032	2,522	23,522	30,042	121
Food and Drug Administration	(3)	(3)	(3)	(3)	(3)	(3)	------	------	16,713	20,766	(3)
Forest Service	4,703	5,272	589	722	344	295	5,636	6,289	7,294	8,476	684
Home Economics	2,858	3,733	341	335	1	(1)	3,199	4,068	14,133	15,013	84
Plant Industry	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	32,669	30,146	(3)
Public Roads	5,352	6,075	1,153	1,317	(1)	(1)	6,505	7,392	10,810	12,821	180
Soil Conservation Service	1,631	4,385	------	10	------	------	1,631	4,395	700	1,166	102
Total	85,513	92,087	4,411	5,218	33,508	34,827	123,431	132,132	273,793	519,273	------

[1] Figures not available.
[2] Approximate figures.
[3] The Bureau of Chemistry and Soils, Food and Drug Administration, and the Bureau of Plant Industry do not maintain collections of books as they are in close proximity to the main library. The circulation of books to members of the bureaus is, therefore, included with those for the Library but circulation figures are available for current periodicals, as this circulation is handled in the bureaus.

At the request of the Department Graduate School, the Library again was kept open after official hours during certain months of the school year to give out books needed in classes in the school. Funds for paying the assistants were provided from the Graduate School funds. The number who used the Library after hours was not, however, sufficient to justify continuing the arrangement during the coming year.

INTERLIBRARY LOANS

The interlibrary loans of the Library are divided into two classes—(1) loans to this Library and (2) loans by this Library. It has also been of interest in the case of both classes to separate the loans from and to libraries outside of Washington from those for libraries in Washington. Detailed statistics of the loans to this Library from libraries in and out of Washington have been kept for the past 25 years in order to show to what extent the collections in Washington are unable to supply the books that are needed in the work of the Department. Statistics of the loans from this Library to libraries and institutions outside of Washington have likewise been kept for an even longer period, to show the use made of the Library outside of the Department, especially by the agricultural colleges and experiment stations. Separate statistics showing the use of this Library in Washington by agencies other than the Department have, however, been kept for only 2 years. A comparison of all these figures shows some interesting facts as brought out below.

In the case of the loans to this Library from libraries outside of Washington, the statistics for the 25 years, 1913–37, show that the smallest number borrowed was 35 in 1918, and that it has never exceeded 100 with the exception of the year 1932 when it was 102, and last year when it was 143. It is

also somewhat surprising that the number for 1913, namely, 91, was the third largest number. That the number should be small is only natural in view of the superior library resources in Washington. The 143 books which were borrowed outside of the city last year were from 42 different libraries. The six libraries from which the largest number were borrowed were the New York Academy of Medicine, 18; University of Chicago, 13; Harvard University, 11; John Crerar Library, 10; Iowa State College, 8; and the New York State College of Agriculture, 7. There were five volumes borrowed from each of the following five libraries: American Museum of Natural History, Boston Medical Library, Johns Hopkins University, Welch Memorial Library, and Yale University. The remaining 51 volumes were borrowed from 31 different libraries.

The figures for the loans from other libraries in Washington during 1913 to 1937 show that the smallest number for any year was 3,502 in 1923, and the largest 6,774 in 1916. The number for 1913, namely, 5,677, was a trifle larger than the number for 1937, which was 5,663. The 10 libraries from which the largest number of books were borrowed were: Library of Congress, 4,626; Army Medical Library, 516; National Museum and Smithsonian Institution, 113; Weather Bureau,[1] 89; Geological Survey, 73; National Bureau of Standards, 54; Patent Office, 42; National Institute of Health, 36; Public Health, 22; and Bureau of Fisheries, 19. The remaining 70 were borrowed from 17 different libraries.

The figures regarding the loans to this Library for the past 25 years have additional interest when averages for the full period and by 5-year periods are shown, as in table 8.

TABLE 8.—*Summary of books borrowed from other libraries in and out of Washington, fiscal years 1913–37*

Years	Outside of Washington		In Washington	
	Total	Average per year	Total	Average per year
1913–17	379	75.8	29,090	5,818
1918–22	271	54.2	21,969	4,394
1923–27	320	64.0	20,208	4,042
1928–32	374	74.8	23,819	4,764
1933–37	453	90.6	27,330	5,446
	1,797	71.9	122,416	48,967

From the figures in table 8 it will be seen that the average of the books borrowed outside of Washington in the last 5-year period is greater than that of the first 5-year yeriod, but that the average of the books borrowed from libraries in Washington in the last 5-year period is not equal to that of the first period, although the average has risen in the last decade. Whether or not these figures have any special significance in connection with the research work of the Department or indicate that the resources of this Library are better able to meet the demands of the Department's research workers, is difficult to say. In any case, it is interesting to have the facts which the summary gives as they seem to indicate that these loans under normal conditions are not likely to increase to any great extent in the near future. As far as the Library of Congress loans are concerned, this is particularly true, as it is no longer able to lend as freely as in the past, partly because many more books have been placed in its rare book room and partly because the increased demands upon it from many new Government agencies have made necessary a restriction in its loans and the requirement that certain classes of books be consulted in the

[1] Although the Weather Bureau is a part of the Department, the Bureau library has been administered as a separate library, aside from the fact that its books and periodicals have been purchased from the appropriation of the Department Library since 1907. Its holdings are not, however, recorded in the catalog of the Department Library.

Library of Congress. The number of books borrowed from the Library of Congress during the year was 533 less than in 1936.

The record which has been kept for the past 2 years of books borrowed from this Library by other Government libraries, and by private institutions and organizations in Washington shows that these loans were 2,048 during the year compared with 3,544 in the fiscal year 1936. It is, however, necessary to explain that in the figures for 1937 are included the loans to the Resettlement Administration for the full year, whereas strictly only those for the first half of the fiscal year should have been included, since the Resettlement Administration was merged with the Department in January 1937. Of the 60 different agencies in Washington outside of the Department which have used the Library's facilities, the following were the largest borrowers: Resettlement Administration, 1,424; National Institute of Health, 368; Social Security Board, 349; Farm Credit Administration, 208; Patent Office, 159; Works Progress Administration, 137; National Museum and Smithsonian Institution, 121; Tennessee Valley Authority, 89; National Bureau of Standards, 82; and Geological Survey, 29.

Statistics in regard to the books lent by this Library outside of Washington are given in table 9, but to provide a true picture of the use of the Library in the past year and in the fiscal years 1935 and 1936, there have been included in the interlibrary loan statistics for these 3 years not only the books and the photostat and typed copies of articles, as has been customary for many years previous, but also the film copies and prints of articles which the Library began to supply in November 1934 in lieu of sending the volumes themselves.

TABLE 9.—*Interlibrary loans outside of Washington, fiscal years 1935–37*

Item	Books			Films or prints			Photostat copies			Typed copies			Total		
	1935	1936	1937	1935	1936	1937	1935	1936	1937	1935	1936	1937	1935	1936	1937
Department of Agriculture field service	558	662	783	37	117	135	----	----	----	----	----	----	595	779	918
Land-grant colleges and experiment stations	797	554	504	309	604	667	----	----	----	----	----	----	1,106	1,158	1,171
Other colleges, universities, and organizations	280	264	261	248	560	841	----	----	----	----	----	----	528	824	1,102
Commercial firms	60	51	21	370	596	1,670	----	----	----	----	----	----	430	647	1,691
Individuals	64	18	17	69	145	437	----	----	----	----	----	----	133	163	454
Foreign organizations and individuals	39	17	22	45	184	316	----	----	----	----	----	----	84	201	338
Total	1,798	1,566	1,608	1,078	2,206	4,066	----	----	----	----	----	----	2,876	3,772	5,674
Unclassified	----	----	----	----	----	----	28	27	7	18	20	2	46	47	9
Grand total	1,798	1,566	1,608	1,078	2,206	4,036	28	27	7	18	20	2	2,922	3,819	5,683

The figures in table 9 show that a total of 2,922 volumes in 1935, 3,819 volumes in 1936, and 5,683 volumes in 1937 were made available to out-of-town users either through the loan of the volumes themselves or by furnishing photographic or typewritten copies of special articles. It is interesting to contrast this last figure of 5,683 with the number of volumes lent in 1912, namely, 620. A more detailed description of the film copying service is given in the following paragraphs.

BIBLIOFILM SERVICE

The work of the Library connected with the Bibliofilm Service has been in charge during the year of Mrs. Roberta C. Watrous, bibliographical assistant in the Readers' Division, who has prepared the following report.

This year, for the first time, there are no major changes to record. During the year the Bibliofilm Service was operated by Science Service, under the cooperative agreement which became effective January 1, 1936, as explained in the report for last year. According to the agreement, the Library has procured the books, carried on the necessary bibliographical work, and furnished

the office and laboratory space for the Bibliofilm Service. Science Service has conducted the business and financial work, as well as the routine and experimental photographic work. It was expected that a reading machine suitable for use with the microfilms produced by the Bibliofilm Service would be made available during the year but this expectation has not been fulfilled. The only change in conditions has been an increase in the prices charged, effective May 15, 1937. The service charge for each item was increased from 10 to 20 cents, and the price per page of photoprints from 5 to 10 cents. The price per page of microfilm remains 1 cent.

There has been a large increase in the number of orders received during the year. In the fiscal year 1936 the total number of items supplied was 2,206. In 1937 orders were received for a total of 5,401 items, of which 4,452 were supplied and 949 not supplied.

A notable feature of the service during the year was the popularity of the photoprints, which accounted for more than half the number of items ordered. This popularity was probably due in large part to the fact that they serve much the same purpose, but are less expensive than photostats made by commercial firms. In all except 3 months (November, December, and June) more orders were received for photoprints than for film copies, and for the year there were 435 more orders for photoprints than for film copies.

The largest number of orders received in any month was 746, in March 1937, of which 601 were filled. The smallest number of orders received was 310, in September 1936, of which 271 were filled. It is significant to compare the average number of orders filled per month during the year, 371, with the peak figure for the year before, 332, in June 1936. Orders were received during the year from every State in the Union, Hawaii, Philippine Islands, Puerto Rico, and the following foreign countries: Argentina, Australia, Brazil, Canada, China, France, Great Britain (England and Wales), India, Iraq, Lithuania, Netherlands, Portugal, and Switzerland.

By far the largest users of the Bibliofilm Service are commercial firms (classes 4 and 11 of table 11) with a total of 2,131 film and photoprint copies ordered, of which 799 were for film copies and 1,332 for photoprints. Of these orders we were able to fill 660 and 1,069, respectively, a total of 1,729.

Because of the difficulties in using the film copies, and the cost of the photoprints, it has not been feasible often to substitute microfilms or photoprints for books requested by field workers. Nevertheless, there was an increase from 117 to 135 in the number of copies ordered from the Bibliofilm Service by Department field workers.

Statistics of interlibrary loans outside of Washington, which are given in table 9, include the statistics of film and photoprint copies sent outside of Washington, but tables 10 and 11 give the complete statistics regarding all the film and photoprint copies furnished to users both in and out of Washington.

TABLE 10.—*Number of items for which orders were received, filled, and not filled, by months, fiscal year 1937*

Month	Ordered			Filled			Not filled		
	Film	Print	Total	Film	Print	Total	Film	Print	Total
July	118	281	399	107	211	318	11	70	81
August	158	214	372	144	174	318	14	40	54
September	124	186	310	107	164	271	17	22	39
October	158	285	443	144	251	395	14	34	48
November	224	203	427	187	153	340	37	50	87
December	217	168	385	176	141	317	41	27	68
January	218	232	450	178	205	383	40	27	67
February	266	317	583	205	263	468	61	54	115
March	301	445	746	237	364	601	64	81	145
April	260	202	462	221	169	390	39	33	72
May	240	189	429	198	151	349	42	38	80
June	199	196	395	149	153	302	50	43	93
Total	2,483	2,918	5,401	2,053	2,399	4,452	430	519	949

TABLE II.—*Number of items for which orders were received and filled, by classes of users, fiscal year 1937*

Class	Users	Received			Filled		
		Film	Prints	Total	Film	Prints	Total
1	Department of Agriculture field service	51	89	140	49	86	135
2	Land-grant colleges and experiment stations	387	390	777	322	345	667
3	Other colleges, universities, and organizations	708	350	1,058	557	284	841
4	Commercial firms	787	1,275	2,062	649	1,021	1,677
5	Individuals	225	306	531	185	252	430
6	Foreign organizations and individuals	199	166	365	180	136	316
7a	Department of Agriculture bureaus in Washington	7	19	26	7	19	26
7b	Department of Agriculture Library	49	35	84	49	35	84
8	Other Government departments in Washington	25	1	26	20	1	21
9	Individuals in Washington	6	26	32	5	22	27
10	Colleges, universities, and organizations in Washington	27	204	231	19	150	169
11	Commercial firms in Washington	12	57	69	11	48	59
	Total	2,483	2,918	5,401	2,053	2,399	4,452

BIBLIOGRAPHICAL WORK

During the year three additions were made to the mimeographed series of the Library entitled "Bibliographical Contributions," as follows: No. 29, References on Agricultural Museums, August 1936; No. 30, References on the Great Lakes-Saint Lawrence Waterway Project, October 1936; No. 31, References on Economic History as a Field of Research and Study, October 1936. All of these numbers were prepared by Everett E. Edwards of the Division of Statistical and Historical Research, Bureau of Agricultural Economics.

The principal bibliographical undertaking of the Library was the completion of the List of Periodicals Currently Received in the Library which was published as Miscellaneous Publication No. 245 of the Department.

In the Bureau of Agricultural Economics library the following bibliographies were issued in the series entitled "Agricultural Economics Bibliographies":

No. 65. Farm Youth in the United States; a Selected List of References to Literature Issued since October 1926. (Supersedes No. 17.)

No. 66. Measures of Major Importance Enacted by the Seventy-fourth Congress; January 3 to August 26, 1935, and January 3 to June 20, 1936.

No. 67. Crop and Livestock Insurance; a Selected List of References to Literature Issued since 1898.

No. 68. Incidence of the Processing Taxes under the Agricultural Adjustment Act; a Selected List of References.

No. 69. Large scale and Corporation Farming; a Selected List of References. (Supplements No. 30; supersedes No. 46.)

No. 70. Farm Tenancy in the United States, 1918–1936; a Selected List of References. (Supersedes No. 59.)

In the Bureau of Agricultural Engineering Library two extensive bibliographies were prepared by the Librarian, Mrs. Dorothy W. Graf, one entitled "Bibliography of Land Drainage," and the other entitled "Bibliography of Agricultural Engineering."

In the Bureau of Entomology and Plant Quarantine library, the principal bibliographical work was in connection with volume 5 of the Index to the Literature of American Economic Entomology covering the years 1930–34, which will probably be ready for publication in the fall, the actual indexing having been completed in March 1937. It is estimated that approximately 45,000 references have been assembled.

In the Office of Experiment Stations library, the List of Bulletins of the Agricultural Experiment Stations for the calendar years 1935 and 1936 is nearing completion. Other lists which are currently prepared are the lists of articles written by experiment station workers but published in outside journals, and the lists of extension publications, both of which are published regularly in Agricultural Library Notes.

In the Bureau of Public Roads library, a Bibliography on Highway Lighting was compiled by Mildred A. Wilson of the library staff, and was published as Miscellaneous Publication No. 279 of the Department. Another bibliography on highway safety is nearly completed.

The publication of Agricultural Library Notes was continued throughout the year, as were also the following current lists issued by the branch libraries. The names of the libraries responsible for the lists are given in parentheses after the title: Agricultural Economics Literature (Bureau of Agricultural Economics library); Current Literature in Agricultural Engineering (Bureau of Agricultural Engineering library); Cotton Literature (library of the Division of Cotton Marketing, Bureau of Agricultural Economics); Entomology Current Literature (Bureau of Entomology and Plant Quarantine library); Forestry Current Literature (Forest Service library); Plant Science Literature (Bureau of Plant Industry); and Highways Current Literature (Bureau of Public Roads library). A new list entitled "Soil Conservation Literature, Selected Current References" prepared in the Soil Conservation Service library, was begun in January 1937. It is a mimeographed bimonthly publication.

TRANSLATIONS

Little progress has been made in connection with the proposed translation exchange service described in the report for last year. One, however, of the State agricultural colleges, the North Carolina State College of Agriculture, has continued to send to this Library regularly the scientific translations prepared in its modern languages department. Two of the divisions of the Bureau of Plant Industry, namely, Forest Pathology and Sugar Plant Investigations, and the Forest Service also send their translations regularly to the Library. Occasional translations have been received from other institutions and Department workers. The Library is grateful for this cooperation. The translations received by the Library are regularly listed in Agricultural Library Notes with the exception of the botanical translations which are listed in Plant Science Literature.

BUREAU AND DIVISION LIBRARIES

A list of the branch libraries in the various bureaus and offices and data in regard to them are given in table 12. Cataloging statistics are included in table 4 and statistics of circulation are given in table 7. The other regular activities are described in the body of the report under their appropriate headings. For the most part the work has been carried on along the lines described in previous reports. Only the changes during the year will, therefore, be mentioned.

TABLE 12.—*Summary of statistics of bureau libraries*[1]

Bureau or division	Employees	Books	Pamphlets	Periodicals currently received	Registered borrowers	Registered borrowers to whom periodicals are circulated	Shelving	Space occupied
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Linear feet*	*Square feet*
Agricultural Economics	25	[2] 86, 133	--------	2, 384	944	163	4, 947	7, 096
Cotton Marketing	2	564	2, 100	327	55	55	126	1, 096
Agricultural Engineering	2	4, 432	9, 850	265	204	45	834	893
Animal Industry	3	(3)	(3)	710	98	83	119	540
Animal Husbandry	1	664	6, 435	247	84	51	746	630
Dairy Industry	2	1, 475	5, 800	373	78	73	495	639
Entomology and Plant Quarantine	5	13, 252	15, 061	856	177	72	2, 190	2, 748
Bee Culture	1	2, 400	825	80	(3)	(3)	624	600
Experiment Stations	8	4, 782	101, 076	1, 332	121	73	1, 806	2, 650
Fertilizer Research	1	4, 900	(3)	123	85	50	623	1, 290
Forest Service	2	[2] 30, 500	--------	500	684	363	1, 425	1, 564
Home Economics	2	5, 000	(3)	337	84	63	685	736
Plant Industry	10	[4] 570	(3)	613	--------	181	140	650
Public Roads	4	[5] 17, 439	23, 618	424	180	148	2, 627	2, 209
Soil Conservation Service	4	980	937	174	102	62	107	761
Solicitor's Office	1	[5] 7, 000	--------	(3)	(3)	(3)	1, 602	1, 433

[1] The Weather Bureau library is administered separately, with the exception that the books and periodicals are purchased from the appropriation of the Library of the Department, the sum of $1,000 being set aside each year for this purpose.
[2] Includes pamphlets.
[3] Figures not available.
[4] Does not maintain a collection of books.
[5] Approximate figures.

In the Bureau of Agricultural Economics library the reference work has been growing steadily in quantity and diversity of subject matter and it was felt desirable to devise some method of measuring this part of its work. A plan was therefore worked out whereby daily records were kept of the questions asked. These were classified under six headings and tabulated. This tabulation showed that 26,264 questions were asked during the year.

The Bureau of Agricultural Engineering library, on June 18, 1937, moved into its permanent quarters on the fifth floor between wings 3 and 4, rooms 5026–5032. This is the third time since 1931 that it has been moved but each change has been an improvement. While its space is now 147 square feet less than formerly, by a more efficient arrangement of the collection and the addition of some steel shelving, an increase of 153 linear feet of shelving was obtained. On May 1, 1937, a permanent library assistant was added to the staff of the library because of the increased work.

Through June 15 the work of the Animal Husbandry Division library was continued along the same lines as previously maintained, being handled by one employee who served the Animal Husbandry and Animal Nutrition Divisions of the Bureau of Animal Industry. These offices, because of their distance from the Bureau library, could not very well be served by it. In arranging for the removal of these Divisions from Temporary Building F to their permanent quarters in the South Building, plans were made by the Bureau to discontinue the Animal Husbandry library as a unit and no space was provided for filing the collection of books and back numbers of periodicals formerly kept there. A small room was assigned in the new quarters for the use of an assistant in handling part of the library work, but it is expected that the reference and circulation work, with the possible exception of a portion of the periodical circulation, will be handled in future by the Bureau of Animal Industry library. A working collection of books relating to animal breeding, feeding, maintenance, and allied subjects was retained in each of the various offices and the most recent volumes of the herd and flock books for reference in connection with the certification of pedigrees were also retained. As the file of Department publications, totaling approximately 400 volumes in permanent and temporary binders, were duplicates of copies on file in the Department Library, they were transferred to the National Agricultural Research Center at Beltsville, Md. The remainder of the books were returned to the Department Library on June 22.

The Bureau of Home Economics library was moved on June 22, 1937, from rooms 6051–6059 to rooms 6063–6067. New steel shelving has been ordered to replace the old wooden shelving which had been moved with the library three times since the library was established.

In the Bureau of Plant Industry library an interesting experiment was carried out during the year. As part of a larger project of the Works Progress Administration, the botany and plant pathology special catalogs were copied on 16-mm film. Preceding the filming considerable revision was made of about one-half of the botany catalog, but owing to the illness of the assistant librarian of the Bureau, the second half had to be copied without revision. The film copies which were made have been deposited in this Library by the Works Progress Administration. Libraries interested can have copies made at the regular rates asked by the photographic firms which are equipped to do this work. In January 1937 the Library lost a valued friend in the death of Frederick V. Coville, of the Bureau of Plant Industry. A partial account of his services to the Library was published in Agricultural Library Notes for February 1937.

In the Bureau of Public Roads library 1,128 linear feet of new steel shelving and also a number of new card cabinets and filing cases were added which have greatly improved the physical equipment of the library. The addition of this equipment was made possible by the additional space assigned to the library at the close of the previous fiscal year.

In the Soil Conservation Service library an additional room was obtained in January 1937. The work of the library is, however, still very much hampered by being at a distance from a large number of the service personnel whose offices are scattered in several buildings.

LIBRARY QUARTERS

In the preceding paragraphs mention was made of a number of changes in the quarters of the branch libraries in the bureaus. In the main Library no changes were actually made during the year but several changes were definitely

planned. Because of necessary readjustments of the space assignments to various bureaus since the completion of the South Building, the Library was requested by the building committee to give up 2,805.5 square feet of space at the south end of wing 4 and to take in place of it equivalent space in wing 5. The required changes in the layout of the Library offices involved the moving of the Catalog Division from rooms 1041–1055 on the north corridor to rooms 1504–1518 in wing 5 opposite the reference room, the moving of the Librarian's office from rooms 1405–1415 to the space formerly occupied by the Catalog Division, the moving of the bindery section from rooms 1434–1444 to the rooms formerly occupied by the Librarian's office, the moving of the workroom for duplicates from rooms 1439–1441 to rooms 1527–1529, and the moving of the supply room from rooms 1433–1437 to 1520–1522.

Other changes involved the moving of the closely related offices of certain bureaus and of the American Documentation Institute for which the Library provides space in accordance with cooperative agreements with these offices, namely, the moving of the horticultural trade catalog collection (in charge of M. R. Newman, of the Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry) from rooms 1506–1510 to rooms 1531–1535; the moving of the agricultural history collections (in charge of E. E. Edwards, Bureau of Agricultural Economics) from rooms 1447–1449 to rooms 1537–1545; and, most difficult of all, the moving of the laboratory of the Bibliofilm Service from rooms 1448 and 1451 to rooms 1547–1551. Although requiring much work, the changes will mean on the whole a decided improvement.

LIBRARY STAFF

In the Library 39 permanent employees were carried on the rolls at the close of the year, and 73 by the bureau and office libraries, making a total of 112. Of this number, 15 were in administrative positions, including the Librarian of the Department, the heads of divisions in the main Library, and the librarians of the bureaus; 64 were assistant librarians, junior librarians, library assistants, and junior library assistants; 12 were under and minor library assistants; 14 were clerical assistants; and 7 were messengers.

At the annual conference of the American Library Association in New York in June 1937 the Library was represented by the Librarian, the heads of two of the divisions of the Library, and the librarians or library assistants of several of the bureau libraries. This representation of the Library was possible on account of the close proximity of New York to Washington. At the meeting Janice S. Brown, of the Bureau of Plant Industry library staff, acted as secretary of the Agricultural Libraries Section. Louise O. Bercaw, of the Bureau of Agricultural Economics library, and Cora L. Feldkamp, librarian of the Office of Experiment Stations, continued to serve during the year on the Committee on Cooperative Bibliographical Aid of the Agricultural Libraries Section, the former acting as chairman. The lists prepared by the Committee are published regularly in Rural America, organ of the American Country Life Association. During the year the Librarian of the Department was elected as a member of the research board of the American Library Institute for the 5-year period ending December 31, 1941, and also continued to serve as a member of the Board on Resources of American Libraries, American Library Association, as president of the International Committee of Agricultural Librarians, and as chairman of the subcommittee of the International Relations Committee, American Library Association.

FINANCES

The receipts and expenditures for the Library for the fiscal years 1928–37 are shown in the financial statement (table 13) at the end of the report.

SEVENTY-FIFTH ANNIVERSARY

In this year which marks the seventy-fifth anniversary of the establishment of the Department, the report should not close without some recognition of the event and account of the history of the Library, its establishment being linked with that of the Department, although its foundations were laid earlier in the Agricultural Division of the Patent Office. The report of the Library for 1912, the year of the fiftieth anniversary, contained an historical sketch of the Library up to that time. Because of space limitations in the present report, it

is only possible to give some of the outstanding facts connected with its growth in the past 25 years.

In 1912 the Library contained 122,043 accessioned volumes and received currently 1,948 periodicals, while it now contains 272,696 accessioned volumes and receives currently 4,811 periodicals. Its appropriation then was $40,500, while now it is $105,420. The general catalog of the Library in 1912 contained approximately 286,000 cards, contrasted with over a million at the present time. In 1912 the Library staff of the whole Department was a little less than half of the present staff. The number of bureaus and offices of the Department, exclusive of the Weather Bureau, which had trained librarians in charge, was seven. Now there are 13 branch libraries in the bureaus and offices and 3 subbranches, all of which, with 2 exceptions, have trained librarians in charge.

In 1912 the Library occupied the greater part of the basement of the East Wing with many books in cases in the corridors. The rooms being designed for laboratories, were not well adapted to library use and there was no room for expansion. Nevertheless, the Librarian in the report for 1912 dwelt hopefully on the future, saying that the many inconveniences of temporary quarters were overlooked as much as possible because of the prospect of adequate and convenient quarters especially designed for the Library which, according to the plans at that time, were to be provided in the new Administration Building when built. The report went on to say that this would be "an event of special importance to the Library, for at no time in its history had it been housed in quarters planned for library use." The hope expressed, however, was long in being realized. By 1914 the crowded condition of the library shelves demanded some immediate makeshift arrangement, as the prospect of the completion of the Administration Building was still in the dim future. Therefore, in January 1915, the Library was moved to the Bieber Building, 1358 B Street SW., which had been newly erected for certain offices of the Department. The Library occupied the whole of the first floor and part of the basement, in all 12,270 square feet. While the new quarters provided extra room and were an improvement in other respects, they still left much to be desired, particularly as the Library's neighbor in the basement was the Motion Picture Laboratory which constituted a fire hazard for the Library. In a few years the shelves were again so crowded that the Library was pleading for additional space. In 1922 plans were in progress for the removal of the Motion Picture Laboratory and the assignment of its space to the Library. By this time it had also become evident that the old plans for the Administration Building connecting laboratories A and B, which had contemplated provision for the Library on the top floor, would have to be abandoned, as the space which would be available was not adequate even for the Library collections at that time. The conviction was then expressed that a separate building for the Library in a central location would be the only satisfactory solution. In 1923 the book collections in the Bureau of Plant Industry library were transferred to the main Library, as the Bureau had decided not to maintain a book collection in the Bureau. That the Library was able to file the collection was only possible because of the additional space obtained through the removal of the Motion Picture Laboratory. The space provided for growth was, however, so limited that in a short time it was necessary to make a plea for all of the remaining space in the basement which at that time was assigned to other offices.

In 1926 the passage of the Public Buildings Act and the expected assignment of several million dollars to the Department of Agriculture for its building program again gave reason for hope that new and permanent quarters for the Library would actually be provided in a separate building planned for its use. The partial realization of this hope came in 1932 when the Library was moved to the new permanent quarters planned for its use in the South Building which included a wing for the stacks. It was not, however, until December 1934 that the stacks were finally completed. The equipment and furnishings are plain but with the readjustments and improvements that have recently been made, the Library can at least be said to be well housed and as conveniently arranged as is possible in a building designed for offices and laboratories. With these improved conditions the Library will be able with less difficulty to perform its proper service.

TABLE 13.—*Financial statement, fiscal years 1928–37*

RECEIPTS

	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937
Source:										
Library appropriation:										
Salaries	$60,000.00	$69,100.00	$69,300.00	$71,860.00	$74,120.00	$74,120.00	$64,998.00	$67,613.00	$70,520.00	$70,520.00
General expenses	24,180.00	26,580.00	32,700.00	32,700.00	36,500.00	31,980.00	35,225.00	24,074.00	29,292.00	33,280.00
Total	84,180.00	95,680.00	102,000.00	104,560.00	110,620.00	106,100.00	100,223.00	91,687.00	99,812.00	103,800.00
Department printing and binding fund	10,045.07	8,199.46	10,614.72	13,662.86	25,207.11	19,666.69	22,993.68	17,705.97	18,033.98	23,198.78
Grand total	94,225.07	103,879.46	112,614.72	118,222.86	135,827.11	125,766.69	123,216.68	109,392.97	117,845.98	126,998.78

EXPENDITURES

	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937
Books and serials	$13,093.14	$14,817.52	$18,806.78	$19,971.38	$19,047.74	$13,873.16	$11,658.72	$12,714.53	$16,296.51	$17,088.26
Periodicals	8,845.99	9,061.06	9,431.94	9,351.98	10,402.63	9,068.76	10,259.94	10,994.21	9,913.84	10,521.55
Maps				28.50	8.43	56.30	11.81	1.50	1.68	5.25
Index cards	155.41	165.75	149.98	227.68	299.07	188.97	167.80	130.88	136.92	120.51
Furniture, shelving, and miscellaneous equipment	1,133.24	821.04	1,569.37	898.32	4,019.44	2,806.80	860.65	516.46	1,623.76	1,832.10
Traveling expenses	108.04		29.64	78.87	29.63		40.38		17.50	27.70
Freight, express, and trucking service	107.87	127.97	113.00	125.65	169.42	132.79	86.11	78.62	93.87	90.83
Supplies	750.01	707.35	708.47	651.73	944.77	737.62	650.31	455.48	709.94	782.03
Repairs	326.99	641.74	962.92	228.64	1,831.78	3,223.09	167.24	244.81	1,164.71	206.24
Newspapers		809.90	974.91	1,105.50	784.86	815.80	1,094.97	1,168.34	1,165.14	660.71
Telephone and telegraph						276.86	351.44	394.15	320.05	490.53
Special and miscellaneous expenses (general char service and cleaning supplies)	2,760.00	3,300.00	3,300.00	3,300.00	3,300.00	4,599.98	1,558.10			
Salaries (exclusive of char service)	56,895.09	65,226.70	65,952.43	68,365.06	69,333.05	70,173.35	59,605.36	64,982.60	68,226.79	70,347.60
Total	84,175.78	95,679.03	101,999.44	104,333.31	110,170.82	105,953.48	86,512.83	91,681.58	99,670.71	102,173.31
Printing	438.25	553.00	349.43	635.79	659.66	997.62	466.09	569.98	2,017.26	3,889.55
Binding	9,606.82	7,646.46	10,265.29	13,027.07	24,547.45	18,669.07	22,527.59	17,135.99	16,016.72	19,309.23
Grand total	94,220.85	103,878.49	112,614.16	117,996.17	135,377.93	125,620.17	109,506.51	109,387.55	117,704.69	125,372.09
Credit received for duplicates exchanged with book dealers and libraries	147.30	455.76	335.64	201.96	270.67	98.85	149.85	193.24	117.91	215.50

[1] Outstanding liabilities $1,626.69.

TABLE 13.—*Financial statement, fiscal years 1928–37*—Continued

SUPPLIES AND REPAIRS

	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937
Supplies:										
Cleaning and toilet	$104.76	$107.62	$95.07	$84.34	$67.10	$367.62	$164.00	$8.56	$5.30	$1.87
Stationery	107.11	208.67	214.74	248.22	385.71	186.64	137.16	80.30	154.61	270.33
Miscellaneous office	488.76	264.74	289.19	280.04	391.03	165.95	320.65	315.40	502.57	472.58
Binding material	49.38	126.32	109.47	39.13	100.93	17.41	28.50	51.22	46.96	37.25
Total	750.01	707.35	708.47	651.73	944.77	737.62	650.31	455.48	709.44	782.03
Repairs:										
Carpentry work	65.43	160.74	188.13	68.88	903.72	2,359.24	44.34	78.36	92.42	41.78
Electrical work	31.46	191.04	241.12	43.50	37.55	125.90	57.42	17.08	604.37	78.22
Typewriters	20.92	27.19	15.43	25.45	36.31	73.39	34.36	9.01	40.44	14.79
Painting	135.05	186.59	124.30	14.38	759.29	496.76	----------	----------	140.70	12.88
Miscellaneous	74.13	76.18	393.94	76.43	94.91	167.80	31.12	140.36	286.78	58.57
Total	326.99	641.74	962.92	228.64	1,831.78	3,223.09	167.24	244.81	1,164.71	206.24

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - Price 5 cents

UNITED STATES DEPARTMENT OF AGRICULTURE

OFFICE OF THE SECRETARY

DIVISION OF OPERATION

REPORT

of the Chief of the

DIVISION OF OPERATION, 1937

TABLE 13.—*Financial statement, fiscal years 1928–37*—Continued

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C., September 13, 1937.

Hon. HENRY A. WALLACE,

SECRETARY OF AGRICULTURE.

DEAR MR. SECRETARY:

I submit herewith the report of the work of the Division of Operation for the fiscal year ended June 30, 1937.

Sincerely yours,

Joseph Stacey

CHIEF.

INTRODUCTION

In this, the third annual report of the Chief of the Division of Operation since its establishment as a sparate operating unit reporting drectly to the Secretary, the principal accomplishments of the year are briefly described.

This Division is responsible for the management of the buildings and other facilities occupied or used by the Department of Agriculture in the District of Columbia, the telephone and telegraph service, the mails and files, the Departmental post office, and the motor transport, emergency rooms, and other service units. The Chief of the Division acts as real estate officer of the Department and as personnel and financial administrative officer for the internal operation of the Office of the Secretary. He is responsible for the preparation of the budget estimates for the Office of the Secretary and approves all expenditures made under appropriations for that office. He is also responsible for handling with the public and with other governmental agencies the miscellaneous matters above described. He supervises the work of his immediate office, which comprises real estate, personnel, engineering advice, appropriation and budget estimates for the Office of the Secretary, and the property section, the labor force, and general directory information service.

During the fiscal year the resources of all the units comprising the Division were greatly taxed incident to the large volume of work performed for the Resettlement Administration and for the various bureaus of the Department.

The appropriations and expenditures for the Office of the Secretary during the past 3 fiscal years are shown in table 1.

TABLE 1. -- Appropriations and expenditures during the fiscal years 1935, 1936, and 1937

Item	1935	1936	1937
Appropriations	$762,369	$764,160	$616,019
Expenditures	735,795	733,054	596,216

GENERAL ACTIVITIES

The unfinished portions of wings 2 and 3 and the connecting Independence Avenue head house of the South Building were completed during the latter part of the fiscal year, thus providing housing facil-

ities for approximately 1,000 additional employees. This brought to completion the Extensible (or South) Building, covering two city blocks, from Twelfth to Fourteenth Streets and from Independence Avenue to C Street, Southwest. The building in its entirety will accommodate approximately 6,000 employees. In order to conserve and utilize space to the best advantage by the bureaus and offices located in both the Administration and South Buildings, the committee on space utilization spent considerable time in planning reassignments in order to consolidate all of the activities of each bureau in the most convenient manner.

The administrative offices of the Resettlement Administration and the Soil Conservation Service have been moved into the South Building and the task of relocating the various bureaus affected thereby is now being accomplished.

The installation of the laboratory equipment for the Bureau of Dairy Industry and the Division of Motion Pictures has been completed in the most part and these activities have been moved to their respective quarters. The quarters vacated in the East Wing by the Bureau of Dairy Industry have been converted into offices and will be utilized by a portion of the Meat Inspection Division of the Bureau of Animal Industry, which activity was compelled to vacate the space it occupied in Temporary Building F, as this structure is to be razed in accordance with the Mall development.

On account of the tremendous growth of the Department it is impossible to house all of its activities in the Mall group of Government-owned buildings and it is necessary to rent a large amount of space in the District of Columbia. The construction of buildings by the Government for the housing of the Department of Agriculture Washington personnel has not kept pace with the growth of the Department. There is urgent need at this time for two buildings; one on block 325, bounded by Virginia Avenue, C Street, Eleventh and Twelfth Streets, and the other to cover the remaining portion of block 326, bounded by C, D, Eleventh and Twelfth Streets. If these two buildings could be erected with reasonable promptness the Department would be able to concentrate the majority of its activities in the group of buildings south of Independence Avenue between Eleventh and Fourteenth Streets. A building on block 325 would provide approximately 224,000 square feet of usable space and the proposed building on block 326 would provide approximately 110,000 square feet of space.

There is another need with involves not only the Department of Agriculture but other Departments as well; that is for the storage of motion-picture and other films. Aerial photography has made such strides in recent years that this Department finds it very difficult to provide adequate storage for these films. It is recommended that serious thought be given to the erection of a building to be used solely for the storage of films.

The Wilson Memorial Archway extending across Independence Avenue from the Administration Building to the South Building and known as the west bridge, was completed on July 22, 1936. The Knapp Memorial Archway, known as the east bridge, was completed on September 15, 1936. These memorials were authorized by Public Resolution No. 33, 73d Congress (S.J.Res.100), which reads as follows:

> "Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the archway connecting the new building of the Department of Agriculture (commonly known as the 'South Building') with the west wing of the main building of the Department of Agriculture shall be designated the 'Wilson Memorial Arch' in memory of James Wilson, Secretary of the Department of Agriculture for sixteen years, and shall be suitably inscribed as such.
>
> "Sec.2. The archway connecting such new building with the east wing of the main building of the Department of Agriculture shall be designated the 'Knapp Memorial Arch' in memory of Seaman A. Knapp, who rendered great service to American agriculture, and shall be suitably inscribed as such.
>
> "Sec. 3. The Grand Council of the National Honorary Extension Fraternity, Epsilon Sigma Phi, is hereby authorized to place, without expense to the United States, in each such memorial arch a suitable memorial tablet; but such tablets shall not be erected until the plans and specifications therefor have been submitted to and approved by the Commission of Fine Arts.
>
> "Approved, June 16, 1934."

The tunnel extending from the Administration Building to the South Building, under Independence Avenue at Thirteenth Street, was completed and put in use on October 26, 1936.

The Agricultural Annex, located at Twelfth and C Streets, Southwest, was turned over to the Department on March 29, 1937. This building was erected by the Treasury Department to provide quarters for the equipment and employees of the Department of Agriculture formerly housed in the Cotton Building located at 300 Linworth Place, Southwest. This building was vacated by the Bureau of Agricultural Economics on April 15, 1937, in order that it might be torn down to make way for the Bureau of Engraving Annex.

The garage in the subbasement of the South Building under court 1 is being utilized to house the official automobiles belonging to the bureaus, and also the trucks assigned to the motor-transport service. Utilzation of this ara afforded the Department an opportunity to release rented quarters for the motor-transport service, effecting a saving of $900 per annum.

SECTION OF MAILS AND FILES AND POST OFFICE

The Mails and Files Section is responsible for the opening, reading, routing, dispatching, indexing, and filing of correspondence addressed to the Secretary of Agriculture, the Under Secretary, and the Assistant Secretary; also that addressed to the Director of Personnel, Director of Finance, and Chief of the Division of Operation. This Section also includes the departmental post office, which is responsible for the receipt, distribution, and dispatch of mail for the entire Department. Records maintained during the year indicate that this Section received 62,265 communications addressed to the Secretary and a total of 213,811 communications addressed to the Department of Agriculture. Outgoing communications signed by the Secretary and other officials of the various branches of the Secretary's Office totaled 41,024.

The messenger pool furnished service on 40,060 calls during the year, and 552,207 interbureau or interoffice communications were handled by messengers and through the pneumatic-tube station located in the file room.

The filing unit recorded a total of 132,415 pieces of correspondence filed. This unit is responsible for the custody of the official seal of the Department for its proper use, in addition to recording and filing of correspondence signed by the Secretary and other administrative officers connected with his office. It is also responsible for the handling of all documents for submission to the Federal Register Division of the National Archives, in accordance with the Federal Register Act. The responsibility of maintaining a complete file of all Proclamations, Executive Orders, Secretary's memoranda, and all memoranda and circulars issued by the units comprising the Office of the Secretary has been assigned to this unit.

Incident to the transfer of the Resettlement Administration to this Department, this section has assisted with the preparation of a correspondence manual and furnished advice and suggestions with respect to handling mail and correspondence in conformity with the established procedure of the department.

With the completion of Wings 2 and 3 of the South Building and the readjustment of space assignments, the pneumatic-tube service was made available to the Bureau of Chemistry and Soils, Food and Drug Administration, Forest Service, Office of the Solicitor, and the Division of Motion Pictures, increasing the volume of carriers handled approximately 20 percent.

The Departme post office handled 10,529,007 pieces of incoming mail for the entir Department and dispatched 4,977,890 pieces. Bulk outgoing mail, incding printed matter and letters collected by truck for delivery to th city post office from various buildings of the Department, totaled 86,848 bags. The interbureau communications distributed totaled 557,20.

MOTOR-TRANSPORT SERVICE

The moto-truck pool comprises a fleet of 25 vehicles used for the performance of necessary general departmental work and available for use by the various bureaus and offices of the Department upon call. General departental service is performed at the expense of the Office of the Secretry, but bureau service is subject to reimbursement from the respectiv appropriations. The cost of operating the motor-truck pool is shown in table 2.

TABLE 2. -- Cost of operating the motor-truck pool for the fiscal years 1936 and 193

Item	1936		1937	
Cost of labor and material:				
Salaries of drivers	$13,981.00		$14,278.32	
Overhead (including drivers loaned by repair garage)	3,642.00		2,272.70	
Repair labor on trucks	3,573.00		2,999,24	
Repair material on trucks	1,291.00		929.71	
Gas and oil	1,654.00		1,995.78	
Total	24,141.00		22,475.75	
Time spent:				
Drayage:	Hours		Hours	
Service with driver	19,457		18,818.50	
Service loaned without driver	28,346		25,289.75	
Cost of labor and material:	Labor	Material	Labor	Material
Drayage billed, reimbursable	$13,304	$1,718	$10,650.79	$1,499.39
Drayage billed, nonreimbursable	8,308	1,226	9,028.02	1,391.15

The repair garage is maintained for the purpose of servicing the various cars comprising the motor-truck pool, the passenger cars authorized for operation in Washington, D. C., and trucks and cars operated by the several bureaus of the Department in the field if and when it is necessary for the drivers of these cars to report to Washington, as is often required where the field office is located within a reasonable distance of the Capital. During the fiscal year several worn-out and unserviceable trucks were replaced with modern, up-to-date equipment. The cost of labor for maintaining the repair garage is shown in table 3.

TABLE 3. -- Cost of labor for maintaining the Department of Agriculture repair garage for the fiscal years 1936 and 1937

Kind of work	1936	1937
Reimbursable work performed	$5,528	$5,200.40
Nonreimbursable work performed	1,292	1,004.33
Work for garage	3,573	2,999.24

Two passenger cars are operated for the use of the Secretary of Agriculture and other officials in the Secretary's Office in the performance of public business. These cars are serviced by the repair garage.

TELEGRAPH AND TELEPHONE SECTION

The Telegraph and Telephone Section is responsible for the maintenance and operation of the telephone and telegraph facilities of the entire Department. In addition to handling the very large volume of incoming and outgoing telegraph business and telephone traffic of the Department, this section audits telephone rental and service vouchers and transmits the same to the several bureaus for payment. The telegraph staff likewise checks and audits telegraph accounts and prepares combined vouchers which are forwarded to the respective bureaus for verification and settlement. The number of telephones in service and the number of telegrams handled in comparison with the fiscal years 1932, 1933, 1934, 1935, 1936 and 1937 are given in table 4.

TABLE 4. -- Number of telephones in use and telegraph messages handled during the fiscal years 1932-37

Fiscal year	Main stations	Extension stations	Total	Telegraph messages (incoming and outgoing)
1932	918	941	1,859	62,462
1933	979	938	1,917	60,257
1934	1,424	1,258	2,682	166,158
1935	1,891	1,535	3,426	213,096
1936	2,082	1,562	3,644	193,189
1937	2,106	1,579	3,685	154,964

It is noted that the use of timed wire service in connection with the dispatch and receipt of telegrams over the teletypewriters which were installed during the fiscal year has resulted in a substantial saving to the Department.

Table 5, which is based on actual count and traffic tests made during the year, shows the estimated number of telephone calls handled by the Department's central switchboard.

TABLE 5. -- Distribution of telephone calls made in the Department of Agriculture 1935-37

Type of call	Estimated number of calls made in 1935	1936	1937
Branch to branch	1/	1/	1/
Outgoing trunks	563,654	859,200	708,314
Outgoing Government trunks	178,653	264,160	252,528
Incoming trunks	2/1,189,309	2/1,536,101	2/1,474,864
Incoming Government trunks	2/ 285,844	2/ 377,314	2/ 363,222
Outgoing tie lines	1/	1/	1/
Incoming tie lines	2/ 635,610	2/ 953,424	2/ 984,320
Outgoing long distance	2/ 17,553	2/ 19,670	2/ 16,669
Incoming long distance	2/ 15,109	2/ 16,813	2/ 13,186

1/ Since the introduction of the automatic system no tally can be made of such calls. A fair estimate based on previous figures would indicate that more than 3,500,000 of these calls were handled through the automatic equipment.

2/ These calls handled by operators.

For 1937 there were audited 229,488 telegrams, for which 557 combined vouchers were prepared, amounting to $107,002.37, as compared with 207,750 telegrams audited, and 253 combined vouchers prepared, amounting to $114,738.40, during the fiscal year 1936.

There were audited and passed to various bureaus and offices for payment 245 telephone-rental vouchers, aggregating $90,371.48, and 97 long-distance telephone toll bills, involving an expenditure of $59,582.40.

BUILDINGS, HOUSING, AND REAL ESTATE

This Section handles matters pertaining to the management of buildings and other facilities occupied or used by the Department in Washington, and furnishes engineering advice in connection with laboratory installations in the various buildings. General engineering assistance is also provided in connection with the utilization of existing facilities and the development of new installations. Much study has been given to problems incident to the occupancy of the South Building, as well as to matters relating to departmental housing problems in general, fire hazards and protection, space requirements and assignments in Washington, and the

preparation and maintenance of adequate building plans and charts, including the compilation of data and reports on the housing of the Department in Government-owned buildings in the District of Columbia.

This Section serves as liaison office between the Department of Agriculture and the Treasury, Interior, and Post Office Departments in the procurement of space in Federally owned structures outside the District of Columbia. It also conducts negotiations with the National Park Service relative to the acquisiion of rented quarters in the District of Columbia and with the Procurement Division of the Treasury Department in connection with rented space in the field. Tentative plans and cabinet sketches of space assignments in Federal structures in the field are examined, and matters affecting the leasing of office, laboratory, storage, garage quarters, and experimental tracts throughout the country for the various branches of the Department are reviewed in this Section.

The continued development of the Federal building program has resulted in the occupancy of a number of completed structures throughout the country. Tentative plans and drawings for a still larger number of buildings have been examined and approved. This has resulted in an increase in the amount of the space occupied in Federal buildings, although the program has not developed with sufficient rapidity to affect the amount of commercial space rented. The deficiency bill carries an item providing for the erection of additional new buildings in various localities.

In order to provide housing facilities for the increased personnel of the various activities, it has been necessary to increase the leased space both in the District of Columbia and at various points throughout the country. During the fiscal year, there was an increase of 34.2 percent over the previous year in the number of leases handled in the Departmental real estate file maintained in the Section. Of this increase, 22.4 percent was due to the transfer to this Department of the Resettlement Administration. In addition, there was an increase of 7.3 percent in the number of leasing transactions reviewed and forwarded to the Procurement Division of the Treasury Department for formal clearance, while the number of transactions not requiring clearance, but which required formal reporting to the Procurement Division, increased 20.1 percent over those reported during the fiscal year 1936.

On December 17, 1935, the President appointed a committee, composed of the Attorney General, the Secretary of the Treasury, and the Acting Director of the Bureau of the Budget, to make a study of the problem arising from the acquisition of real property by the Federal Government and the consequent loss of tax revenues by the States and lesser political units because of the exemption of such property from State and local taxation.

On June 30, 1936, this Division was advised by the Acting Director of the Bureau of the Budget that in order to enable the committee to make an adequate study of the existing conditions, it would be necessary

to prepare a questionnaire giving pertinent data as to cost, area, location, assessed value, fair market value, improvements, etc., for each parcel owned by the Department as of June 30, 1936.

As a centralized record of real property had not heretofore been maintained, it was necessary to request each Bureau to submit the information desired.

With this compilation there is now assembled in this office a complete and centralized control record of the real property owned by the Department, which as of June 30, 1936, had a cost value in excess of $300,000,000 and an estimated fair market value of over $500,000,000.

Plans are now being formulated to maintain this record current by revision of the reports previously submitted and the submission of reports to cover the acquisition of additional property and improvements subsequent to June 30, 1936.

Table 6 shows the space occupied by the various bureaus and offices of the Department at the close of the fiscal year and the total rentals paid.

TABLE 6. -- Space occupied by Department of Agriculture and cost of rentals, 1937

Bureau or organization	Federal buildings		Rented buildings			
	In District of Columbia	Outside District of Columbia	In District of Columbia		Outside District of Columbia	
			Area	Rental	Area	Rental
	Square feet	1/ Square feet	Square feet	Dollars	Square feet	Dollars
Agricultural Adjustment Administration	265,001	23,467	15,000	15,494	253,723	145,031
Agricultural Economics	191,786	169,039	---	---	107,290	52,305
Agricultural Engineering	20,062	9,057	---	---	20,887	6,608
Animal Industry	73,166	88,153	---	---	67,932	34,167
Biological Survey	35,982	47,938	---	---	55,438	15,175
Chemistry and Soils	81,076	881	65,633	12,800	14,255	3,489
Commodity Exchange Administration	4,272	439	---	---	12,536	14,580
Dairy Industry	38,319	---	---	---	---	---
Entomology and Plant Quarantine	83,688	146,254	---	---	491,638	101,908
Experiment Stations	12,159	---	---	---	---	---
Extension Service	67,500	338,677	---	---	4,500	1,140
Food and Drug Administration	67,775	105,930	---	---	1,061	960
Forest Service	40,353	299,804	64,384	59,577	1,354,087	440,505
Home Economics	30,512	---	---	---	---	---
Information	39,469	728	---	---	---	---
Library	57,499	---	---	---	---	---
Plant Industry	255,135	12,924	---	---	64,047	16,829
Public Roads	20,206	92,625	76,236	66,687	139,061	54,607
Resettlement Administration	56,234	107,334	264,045	248,877	992,760	513,692
Secretary	206,495	---	2,500	900	---	---
Soil Conservation Service	5,271	39,420	82,965	107,299	2,317,978	477,170
Solicitor	36,554	17,036	---	---	18,699	13,175
Weather Bureau	36,781	185,425	4,258	2,500	54,181	49,145
Total	1,725,295	1,685,131	575,021	514,134	5,970,073	1,940,486

1/ Exclusive of buildings owned by the Department of Agriculture.

A summary of total space occupied by the Department of Agriculture and the cost of rentals for the years 1934-37 is shown in table 7.

TABLE 7. -- Space occupied by Department of Agriculture and costs of rentals, 1934-37

Year	Federal buildings		Rented buildings			
	In District of Columbia	Outside District of Columbia	In District of Columbia		Outside District of Columbia	
	Square feet	Square feet	Square feet	Dollars	Square feet	Dollars
1934	1,340,879	794,472	156,035	76,841	1,343,957	522,593
1935	1,447,180	897,020	198,690	124,257	2,606,937	846,662
1936	1,618,723	1,382,897	311,771	262,612	4,332,792	1,217,523
1937	1,725,295	1,685,131	575,021	514,134	5,970,073	1,940,486

EMERGENCY ROOMS

An emergency room is maintained in order to furnish first-aid assistance to Department employees requiring emergency attention because of illness or injury occurring during the course of their work.

In order to more conveniently render first-aid treatment to the occupants of both the Administration and South Buildings, the new emergency room is now conducted on the first floor of the Independence Avenue head house of the South Building, namely, Room 1038.

The space and equipment in the old emergency room were inadequate and with the increased personnel occupying the newly completed portions of the South Building, the appointment of an additional nurse was necessary.

The new emergency room consists of two women's rooms with adjacent toilet, a men's room with adjacent toilet, a special case room, a treatment room, supply closet, and nurses' change room. There are six beds for women, two for men, and two for special cases.

The treatment room is equipped with a modern steam sterilizer of sufficient size to meet the needs of any first-aid establishment, a large electric refrigerator, a surgeon's lavatory, modern cabinets, etc.

Work on the new emergency room was started January 16, 1937, and the activities of the old emergency room transferred to the new one on June , 1937.

The emergency-room service is available to approximately 7,000 employees in the Department's Administration, South, and Agricultural Annex buildings. A branch emergency room is maintained in the old Post Office building for the accommodation of the Department's employees housed in that structure.

PROPERTY SECTION

During the fiscal year the Property Section inventoried 12 of the offices which it serves. This work requires an actual physical check of the property in each division to ascertain what property is on hand and to provide a check against the Division records for the purpose of adjusting discrepancies and furnishing to the divisions concerned a written inventory of their property. The surplus-property pool of this unit has reported for turn-in to the Board of Survey of the Department many items of unserviceable property and has reissued or loaned many other items of serviceable property.

This unit has been greatly taxed incident to the inauguration of a system of evaluating the inventories of each unit and preparing it in proper form for submission to the Bureau Accounting Service.

This is in accordance with the procedure which is being established by the General Accounting Office to provide financial as well as physical accountability for all nonexpendable property by the installation of inventorial accounts in the general ledger.

INFORMATION AND DIRECTORY SERVICE

The information desk located at the main entrance to the Administration Building has proved of inestimable value in furnishing information for the guidance of visitors and persons having business to transact with officials of the Department.

Similar information service is now available at the principal (Fourteenth Street) entrance to the South Building. By the establishment of this additional service, it is possible to aid visitors in locating the proper officials or bureaus without undue delay.

REPORT OF THE CHIEF OF THE WEATHER BUREAU, 1937

United States Department of Agriculture,
Weather Bureau,
Washington, D. C., *August 23, 1937.*

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I submit herewith a report of the work of the Weather Bureau during the fiscal year ended June 30, 1937.

Sincerely yours,

Willis Ray Gregg, *Chief.*

CONTENTS

INTRODUCTION

In science and its application to human needs progress is seldom, if ever, a process of steady development. Rather is it characterized by a series of accelerations or sudden spurts interspersed with periods of quiescence, sometimes of retrogression. Meteorology presents a striking example of this cyclic tendency. For a brief period, under the guiding hand and brain of Aristotle, it flashed out in brilliance, then slumbered for 20 centuries. The Renaissance which began a hundred years ago bids fair now to eclipse many fold any former achievements and to bring meteorology to a position of dignity and usefulness quite on a par with that held by other utilitarian sciences. None other can indeed contribute more to human efficiency, to human welfare, and to human happiness than can meteorology, and most of them not nearly as much.

The fiscal year that closed June 30, 1937, afforded some forceful and dramatic examples of the important, at times tragic, part that unfavorable weather plays in human affairs and of the highly constructive role that an efficiently organized weather service can assume in mitigating the effects of such weather. There was the drought of the summer of 1936. Unfortunately dependable predictions for more than a few days in advance are not yet possible, but the day-by-day summaries and analyses of conditions throughout the country, coupled with

short-period forecasts, provided information to the various Government agencies and to the Red Cross which enabled them to reduce suffering and loss to a minimum.

Paradoxically enough, there came in less than half a year one of the most disastrous floods of all time. Economic losses were enormous but they would have been almost infinitely greater had it not been for timely warnings, which likewise kept the deaths resulting from the flood to a comparatively small number.

The year saw also record-breaking freezes in the citrus-fruit districts of California; and a series of aircraft crashes, part of which were caused by unfavorable weather. It is no secret that practically the entire citrus-fruit industry of southern California would have been wiped out if protective measures had not been taken in response to the Bureau's warnings of extremely low temperatures. Almost complete loss actually occurred in groves which had not been provided with heating equipment.

The aircraft accidents emphasized very forcibly that the time is still a long way off, if indeed it ever comes, when weather can be left out of the reckoning in planning aerial flight. And it is proper to point out that, against the few accidents that occurred, hundreds of flights were either postponed or canceled because of warnings of bad weather, and many potential accidents were thus prevented. This is a point often lost sight of. Much is heard of an occasional failure, but little, if anything, about the many lives and the hundreds of millions of dollars' worth of property saved by ships being held in port when storm warnings are hoisted; by special provision for heating or refrigeration of perishable fruits and garden truck when a cold wave or a hot wave is predicted; by concentration of fire-fighting forces at threatened points when weather conditions are favorable for destructive fires in the great forests of the country; and by the transfer of people and property to safer places when a hurricane or a flood threatens.

Almost infinite are the contributions that a wide-awake meteorological service can make to the economic and social life of a people. Yet so prone has man been, until recently, to accept the weather as an unknown quantity in the mathematics of buying and selling, that the possibilities of making use of a knowledge of the weather and its ways are even yet only partially realized. Much still remains to be done in acquainting the public with the manifold types of service, statistical, informational, and prognostic, for a variety of human activities that are available and of high value to them, and in coordinating the service of the Bureau with the functions of relief agencies when disasters threaten.

Special attention is being given to what we have referred to as "an occasional failure." Unfortunately failures do occur in all lines of human endeavor, including meteorological service. Perhaps they will never be entirely eliminated. The important thing is that we recognize their existence and that we concentrate in efforts to bring their number down to an "irreducible minimum."

Within the limits of its resources the Bureau is now doing this very thing. Chief requirements for success in bringing about improvement are: More frequent reports of surface conditions from a closer network of stations; a higher standard of instrumental equipment used on ships, in order to secure more accurate and more detailed data as to conditions over the oceans; a much more complete program of sounding the upper air, undoubtedly one of the most fruitful sources of improvement, as yet barely tapped; and, in many respects most important of all, research and still more research, in order that full and effective application may be made of the more abundant and more accurate observational material that is slowly becoming available. A most hopeful sign for the future is the increasing attention that is being given to basic research by all of the principal meteorological services of the world, and it is the purpose of the Weather Bureau to play a leading part in this field. Of great significance and assistance in this connection is the action taken in recent years by educational institutions in organizing high-grade meteorological departments, embracing both advanced training and research.

In the following pages will be found brief summaries of what is being done in the various lines of the Bureau's service. With insufficient funds even for its ordinary routine functions, progress in bringing about the improvements that are possible and that are vitally necessary in the public interest is slow, but it is definite. As previously stressed, the contribution that a highly efficient weather service can make to the economic and social welfare of a people is very large. Only the opening chapter of the possibilities has thus far been written, although the changes that are now taking place give us some glimpses perhaps of the type and character of service that the future will bring.

METEOROLOGICAL RESEARCH

Active research progressed on a number of problems covering a wide field in meteorology and its practical applications. The results of research by the Weather Bureau are made generally available through the medium of the Monthly Weather Review which, in addition to its function of promptly disseminating climatological and weather data for public use, also provides limited facilities for the publication of contributions to meteorology by personnel of the Bureau and, to a small extent, by others.

Among the more important research papers of most general interest that appeared during the fiscal year may be mentioned: The synoptic air-mass analysis studies by Stephen Lichtblau, Upper Air Cold Fronts in North America (vol. 64, pp. 414–425), and B. Holzman, Synoptic Determination and Forecasting Significance of Cold Fronts Aloft (vol. 64, pp. 400–414); the initial contributions to an investigation of North American cold waves by H. Wexler, Cooling in the Lower Atmosphere and the Structure of Polar Continental Air (vol. 64, pp. 122–136), and Absorption of Radiation by Water Vapor as determined by Hettner and by Weber and Randall (vol. 65, pp. 102–104); a further contribution to the mathematical investigation of flood forecasting by R. T. Zoch, On the Relation between Rainfall and Streamflow—II (vol. 64, pp. 105–121); a comprehensive summary of investigations in long-range forecasting by H. H. Clayton, Long-Period Weather Changes and Methods of Forecasting (vol. 64, pp. 359–376); a study of one of the significant phenomena of hurricanes by I. R. Tannehill, Sea Swells in Relation to Movement and Intensity of Tropical Storms (vol. 64, pp. 231–238); the early parts of a comprehensive investigation in meterological optics by E. W. Woolard, The Geometrical Theory of Halos (vol. 64, pp. 321–325; vol. 65, pp. 4–8, 55–57) with tables computed by C. M. Lennahan; and a contribution to the important subject of ultraviolet insolation by W. W. Coblentz, Methods of evaluating Ultraviolet Solar Radiation in Absolute Units (vol. 64, pp. 319–321).

AIR-MASS ANALYSIS

Although still handicapped by lack of sufficient funds and facilities, the work in air-mass analysis and its applications to forecasting was continued and further developed at the Central Office. The systematic training of selected field personnel was continued to the limited extent possible; and plans were formulated for further extension of the work in the field as rapidly as practicable. Steady progress has been made in the technique of frontal, kinematic, and thermodynamic analyses of surface synoptic maps, upper-air maps, and vertical cross sections through the free atmosphere, and in the prognostic interpretation of these analyses.

Important advances were effected in the coordination of this work with that of the official forecasters at the Central Office. In particular, the 1:30 a. m. and 1:30 p. m. maps, analyzed in detail by the trained personnel of the air-mass section, have been used as a guide for rapid and reliable analyses of the 7:30 a. m. and 7:30 p. m. maps by the forecasters. This procedure has been of material aid to the forecasters in the frontal analyses; the forecasts are expedited, and frequently are issued with more confidence because of greater assurance of a correct analysis of the current map.

The analysis of the 7:30 a. m. map is transmitted daily over all teletype circuits, for use in the field.

Research work accomplished during the year included an investigation of upper-air cold fronts, and studies of air-mass conditions during great floods in eastern United States; a new summary of the characteristics and progressive modifications of air masses over the United States, based on recent data from airplane soundings, was begun.

Under an allotment from the special research fund provided by the Bankhead-Jones Act, an investigation of cold waves in North America was carried on in cooperation with the Canadian Meteorological Service, Massachusetts Institute of Technology, and Bureau of Agricultural Economics. Cold-air masses form from warmer air in the far North during the Arctic winter, by the upward propagation of radiational cooling over the snow-covered continent, until eventually an outbreak occurs in the form of a cold wave which sweeps southward over Canada and the United States. Detailed observations were made of meteorological conditions during the development and subsequent outbreaks of cold air by means of airplane soundings, terrestrial radiation measurements and snow-surface temperature observations at

Fairbanks, Alaska; Fort Smith, Canada; and Fargo, N. Dak.; and a statistical and theoretical study of these and other data was carried on at the Central Office, to investigate the physical processes of the formation of the cold-air masses and the dynamical mechanism of their southward release and propagation. Significant progress was made toward a clearer understanding of these phenomena, although the usefulness of the data for the purpose was limited by the fact that the winter was an abnormally warm one in Alaska and northern Canada; the results of this study should be of considerable value in improving the accuracy and extending the range of cold-wave predictions, and in the solution of other meteorological problems.

LONG-RANGE WEATHER FORECASTING

The active carrying forward of the project of relating precedent temperatures and rainfall at 60 foreign stations with subsequent temperature and rainfall conditions in the United States was impossible owing to lack of W. P. A. funds under which the work was conducted in the previous year. However, group indices of barometric pressure, developed by Sir Gilbert Walker and known as (1) the southern oscillation and (2) the North Atlantic oscillation, were related with temperatures in 12 districts of the United States with time intervals of one quarter, two quarters and three quarters. The North Atlantic oscillation seems to have little relation to temperature conditions in the United States; only 4 correlation coefficients out of 144 were 0.30 or more. The southern oscillation, which gave 28 coefficients out of 144 with values of 0.30 or more and 5 with values of 0.40 or more, apparently shows some significance as a prediction factor. For example, the Atlantic and Gulf States in winter show a positive relation, and the Plateau and Pacific States a negative relation with the southern oscillation two quarters and three quarters preceding. In the summer season, the South Atlantic and Gulf States and the Ohio and Mississippi Valley and Plains States seem to show a negative relation with the southern oscillation three quarters before. It is proposed to work out correlation coefficients between Indian monsoon rainfall and temperatures for the 12 United States districts.

A survey was made of studies that are being pursued in Europe and it was found that a very limited amount of such work is being done. The most active country in investigations of this kind is Germany, where there is a specially organized bureau devoted entirely to long-range forecasting work. The method employed is mostly statistical but partly synoptic. The results of the 10-day and monthly forecasts are said to be satisfactory. However, before undertaking work of a similar nature in this country even in an experimental way, it is proposed to check carefully the results of the German forecasts.

The problem of long-range forecasting is an extremely complex one and progress of investigations in this field is necessarily slow. It is becoming evident that new approaches will be required and it remains for someone with vision to suggest new leads that are not now apparent.

SOLAR-RADIATION INVESTIGATIONS

The observations and investigations of solar radiation which have been conducted by the Bureau for many years are of basic importance in a wide range of meteorological, physical, engineering, biological, and medical problems; and the data are in great demand. This work was strengthened during the year by several improvements in the instrumental equipment and observational technique, the addition of accurate continuous registration of the visible component of radiation from sun and sky at Washington, D. C., and the initiation of absolute measurements of ultraviolet insolation.

IMPROVEMENTS IN EQUIPMENT

As a result of continued investigations carried on in cooperation with the National Bureau of Standards 35 high-power ceiling-light projectors were procured. They project a 500,000 candlepower beam with a spread not greater than 4 degrees. In order to realize the advantage of the more intense beam, base lines are being increased from 500 feet to 750 or more. Measurements of ceilings up to 10,000 feet are being reported.

In order to aid observers in the determination of pressure changes temperature-compensated barographs in which the pressure scale is magnified two

and one-half times and the time scale increased to permit hourly time arcs on the record charts have been provided at 120 stations.

During recent years there have been introduced along airways simple devices for indicating wind direction by means of four electric lamps actuated by the wind vane through contact mechanism. Plans have been made to provide wind-vane bearings equipped with eight contacts instead of four, and also indicators of more pleasing design. This arrangement will permit determination in the office of the position of the wind vane to 16 points of the compass.

A device to make a continuous indication of direction by means of a light spot moving on a dial synchronous with the vane is in course of development in the Instrument Division.

Ten anemometers in which the results of extended experiment and tests have been embodied in actual construction by a contractor have been procured. It is planned to send these to stations chosen to represent widely differing service conditions in order to learn their performance in actual service. They were designed for use up to 150 miles an hour.

A special anemometer, without dials, but equipped with 1/60-mile contact mechanism is now being produced. It is based on sound principles of design and construction and is inexpensive. Plans are under way to procure a number of them for use along airways and elsewhere where measurements of momentary velocity are desired.

Corrosion-resistant steel is now employed exclusively for thermometer backs. In order to reduce weight they are thinner than the aluminum backs formerly used. This has led to some difficulty in mounting them in the older supports, but section directors are finding solutions to overcome this difficulty.

The anathermoscope reported last year is still in the experimental stage. A number of experimental flights with this device were made at Oakland, Calif., airport.

AEROLOGICAL OBSERVATIONS

RADIOMETEOROGRAPHS

The development of radiometeorographs was pursued during the year in cooperation with the National Bureau of Standards. A number of these instruments were released with balloons at Omaha, Nebr., together with the recording type of meteorographs, during November, the international month for 1936, with encouraging results. Experimental flights were also made at Washington, D. C. A modified type of instrument was constructed in the Instrument Division, using a cam, shaped in the form of an Archimedes spiral, for making contacts whereby the range of both the pressure and temperature elements can be extended over 360° of the Olland cycle. An improved type of contact mechanism was designed which makes a positive electrical connection of short duration, thereby avoiding ambiguity of the record. Considerable progress was made in the development of air-driven motors and electric motors operated by flashlight batteries. A governor has been designed to provide a uniform rate of speed. The perfection of these features should eliminate difficulties of clocks stopping at low temperatures. A number of the radiometeorographs developed by Harvard University were purchased and comparisons made with the Government types. Evaluation apparatus was designed and calibration methods developed. A number of the Weather Bureau-type instruments were constructed by a commercial concern and purchased by the Bureau. Study was also made of the types of instruments developed by the California Institute of Technology and foreign governments. By the end of the fiscal year, it was possible to place orders for a considerable number of each of several types of these instruments for regular use at four stations during 1937–38.

COOPERATION

Very close cooperation has continued with the Bureau of Air Commerce in the airway service of the Bureau and with the War and Navy Departments in airplane observations. The War Department continued to make daily flights at the eight Army fields listed in the report for last year, and the Navy Department added Coco Solo, Canal Zone, and St. Thomas, Virgin Islands, to the seven Navy stations shown last year. The Bureau increased to 12 the number of stations where these flights are made under contract with commercial flyers, by adding Miami, Fla.; Oakland, Calif.; Salt Lake City, Utah; and Sault Ste. Marie, Mich.

IMPROVEMENT IN THE METHOD OF MEASURING UPPER-AIR WINDS

In order to determine wind directions and velocities at higher elevations than is now possible with 6-inch pilot balloons, double theodolite observations were started, using 16-inch balloons. When a sufficient number of these two-theodolite observations have been made, the mean ascensional rate will be determined and the larger balloons substituted for the smaller ones in regular single theodolite observations. By virtue of their more rapid ascent and the larger size, not only can they be followed to greater heights and distances, but they will also shorten the time required to make these observations.

INTERNATIONAL MONTH

During November, the international month for 1936, the Bureau made daily sounding-balloon observations at Omaha, Nebr. At the request of F. Paneth, Imperial College of Science and Technology, London, England, air samplers were attached to six of the balloons. Five of the samplers have been found and returned to Professor Paneth for analysis of the helium content of the atmosphere at great heights. Thirty-five out of a total of 37 sounding-balloon meteorographs, released during the month, have been found and returned to the Bureau, where the records are being evaluated. These data will be forwarded to the International Aerological Commission for publication, together with those obtained simultaneously throughout the world.

SERVICE IN AID OF AIR NAVIGATION

Approximately 120 6-hourly weather-reporting stations for airway service were established in areas where meteorological reports were not available. To supplement this program, over 100 of the existing teletype or radio hourly reporting stations along the airways were equipped with additional instruments for the taking of special 6-hourly observations which are run in sequences over the teletype and radio circuits. This program has resulted in a much more complete network of observations for use in connection with the preparation of detailed weather maps at all airport stations along the airways, the analysis of meteorological situations, and improved airway forecasts.

A program of collecting two reports, instead of one, for each airplane clearance from stations along airways not equipped with teletype or radio, was put into effect. The first clearance report is collected about an hour prior to departure and the second just before departure, thus permitting a comparison between them to determine whether conditions are improving, growing worse, or remaining unchanged.

The instrumentation of about 35 important airports along the airways was improved by the installation of ceiling projectors which project a more intense beam of light for illuminating a spot on a cloud layer at night as a means of determining the height of the layer.

The service was strengthened in the United States by the assignment of additional personnel to understaffed stations. Some improvement of service in Alaska and Hawaii was effected by establishment of several new weather-reporting stations on a cooperative basis.

A new airway general supervising and forecast center was established at Arlington, Va. (near Washington, D. C.), during the year, bringing the number of such stations to 11.

There are now 52 first-order airport stations where weather maps, hourly weather reports, pilot-balloon observations, and meteorological advice or forecasts are available. In addition to those, there are 228 stations rendering hourly weather observations, 370 airway stations rendering weather observations at regular times, or on call, to serve scheduled flights, and 132 off-airway stations rendering reports every 6 hours in the airway weather network, or a total of 782 stations. Additional reports from stations in Canada, Mexico, and Central American countries, and from ships at sea, are received. Selected groups of reports from the above are relayed by teletype and radio to all Weather Bureau airport stations every 6 hours for the preparation of weather maps. The 11 airport stations, located at Newark, N. J.; Arlington, Va.; Atlanta, Ga.: Cleveland, Ohio; Chicago, Ill.; Kansas City, Mo.; Dallas, Tex.; Salt Lake City, Utah; Portland, Oreg.; Oakland, Calif.; and Burbank, Calif., supervise the service in their respective districts and issue 6-hourly airway regional and terminal forecasts for the periods 4:30 a. m. to 12:30 p. m.;

10:30 a. m. to 6:30 p. m.; 4:30 p. m. to 12:30 p. m.; and 10:30 p. m. to 6:30 a. m., eastern standard time, based on observations made at 1:30 and 7:30 a. m. and p. m., eastern standard time.

EXPANSION OF THE FIRE-WEATHER SERVICE

The fire-weather service was supplemented during the year by the addition of four new mobile forecasting units assigned to headquarters at Mount Shasta, Calif.; Portland, Oreg.; Seattle, Wash.; and Missoula, Mont. These four units, with the one provided by the United States Forest Service several years ago, and which is now operating in southern California with headquarters at Pasadena, have extended the advantages of this form of intensified service to all western districts, covering the principal forests (Government, State, and private) of California, Oregon, Washington, Idaho, and western Montana.

These mobile units do not replace the service which heretofore has been given in the districts in which they are located. They provide an additional and a more complete and satisfactory aid in the direct control of major forest fires. Observations are collected and charted and daily forecasts are issued from the several headquarters during the season of fire hazard. These forecasts are for the major forests and are localized as conditions warrant. On the other hand, service from the trucks is directed toward a particular fire that is in progress. In effect, the forecaster moves his office and facilities to the scene of the fire where he will be in close touch with those in charge of the fire fighting, and can immediately give information of any expected change in weather conditions which will affect the behavior of the fire.

A mobile unit is essentially a portable meteorological office built into a standard truck chassis and provided with observing, charting, and communication facilities. It is manned by a forecaster and radio operator who always accompany the truck. They must adapt themselves to conditions where the fire is raging; and therefore a camping outfit, tanks for oil, gasoline, and water must be carried with the truck. Communication is provided by a radio receiver and transmitter and by a portable telephone which may be connected with forest telephone lines. Electric current to operate the radio equipment, lights, etc., is furnished by a portable gasoline-driven generator which forms a part of the truck equipment.

Determination as to when the truck shall be sent to a fire rests with a central dispatcher, who usually is an official of the Forest Service charged with fire-suppression work. After arrival at the fire, the unit becomes an integral part of the fire-fighting organization. The first action is to choose a suitable location for the truck and then to set up the meteorological instruments, erect the antenna, and put the radio equipment in readiness for service. The forecaster studies conditions surrounding the fire and familiarizes himself with local topography.

Data for the preparation of synoptic maps showing surface and upper-air conditions are collected and charted. This information is obtained from broadcasts of weather reports made through Navy and Department of Commerce stations and through direct contact with Forest Service radio stations located, for the most part, in forests. Periodic conferences are held between the forecaster and suppression officials for the purpose of formulating plans for control of the fire based on existing and expected changes in weather conditions.

Weather information and forecasts are always of high value to fire fighters. Frequently they are vital. Knowledge as to the force and direction of winds is of particular importance when backfiring is contemplated. A major advantage of the mobile unit is that the forecaster becomes a part of the fire-fighting force, and all of his predictions are directed specifically toward the control of that particular fire.

The relatively frequent occurrence of serious fires and the fact that fire hazard is more or less continuous throughout the season in Western States are reasons for first introducing mobile forecasting units in western fire-weather districts. Extension of such service to central and eastern districts is contemplated when facilities for doing so become available.

EXPANSION OF RIVER AND FLOOD SERVICE

Great floods have occurred in our principal rivers throughout recorded history, and will continue to occur in the future. Plans for flood control promise

to reduce their magnitude and protect favorably situated areas, but as long as communities and industry find it profitable to occupy that portion of the stream channel intended by nature for the passage of floodwaters, accurate and timely forecasting and the methodical evacuation of stricken areas must be integrated into the national plan of river regulation and control. The Weather Bureau fully recognizes its responsibilities in the matter of improving its forecast service to meet changing conditions and the demand for more refined and timely forecasts, but has been limited by the amount of funds available for the purpose.

During the past year increased funds have made possible a beginning on a program to organize the United States into eight hydrologic districts. Within each district an intensive study of the relation of rainfall to run-off will be made, the results of which will be utilized in the development and improvement of river-stage forecasting methods. Two of these districts, one located in the Missouri Valley and the other in the upper Mississippi Valley, have been organized and good progress has been made in the work during the comparatively short time they have been in operation.

The great floods in the Eastern States in March 1936 and in the Ohio and lower Mississippi Valleys in January and February 1937 have forcefully brought to the foreground the necessity for establishing hydrologic districts throughout the whole of the country with the least possible delay. Particularly are they essential to forecasting at important points in headwater areas and in the smaller river basins.

An important step in the expansion of the flood-forecasting service has been made possible under a project in which the Weather Bureau, the Geological Survey, and the Commonwealth of Pennsylvania are cooperating. The objectives of this project are to provide the means of inaugurating a modern, scientific river-forecasting service throughout Pennsylvania, and to establish new sources of basic hydrologic data which are necessary to the program of forecasting and which are indispensable to the design and operation of flood-control works. The project embraces the development of a dependable means of transmitting promptly rainfall and stream-flow data from the index watersheds to the flood-routing and forecasting offices. Approximately 130 recording rain-gage stations are being located in the watersheds of the Allegheny, Monongahela, Susquehanna, and Delaware Rivers. These rain gages are being established on three circuits over which experienced hydrologic engineers will travel on schedule, attending and servicing the gages, and, in season, conducting snow surveys.

Fifteen additional river-gaging stations, 17 daily rainfall stations, and 58 occasional-reporting rainfall stations were established during the year. These stations included many which have been closed since July 1933.

EVAPORATION

Water conservation in many localities must be accomplished through storage reservoirs. The principal loss to stored water is evaporation, the characteristics of which much remains to be learned.

The Bureau has attempted to meet the needs of those using evaporation data in maintaining a system of about 75 class A evaporation stations throughout the country; and while the evaporation work of the Bureau is now on a fairly satisfactory basis, much remains to be done. About 20 new evaporation stations equipped with standard Weather Bureau instruments have been established during the last 2 years. All of these stations are on a cooperative basis with other agencies, the Bureau furnishing the instrumental equipment and the cooperating agency the station site and attendance.

Detailed descriptions of more than 150 evaporation stations using both standard Weather Bureau equipment and other types have been secured and made a part of the records. Observations from most of these stations are now regularly received and will be published when practicable.

Four of the new stations established were in the Great Lakes region in cooperation with the Office of the Chief of Engineers, War Department, in a study of evaporation for all seasons of the year. As nearly as possible the temperature of the water in the evaporating pan is kept the same as that of the water in the Lakes. It is expected that this study will yield interesting and valuable results.

SNOWFALL

In most of the western fourth of the United States human activities are, in a great measure, limited by the amount of water available. In great expanses of this region the rainfall is insufficient to supply the consumptive needs, and recourse must be had to the conservation of water from melting snow in the mountainous areas. To accomplish this many reservoirs have been constructed to conserve the water and mete it out to users when needed.

The operators of these reservoirs, and those charged with the duty of allotting water to users, find it essential to know the approximate water yield that may be expected from the mountain snow fields, and to know the time and rate at which these waters will reach the users on the lower reaches of the various streams. This information can best be obtained through careful and systematic measurement of snowfall, supplemented by snow surveys which determine the depth and water content of the snow mantle. Snowfall data are obtained at the various Weather Bureau stations throughout the country and snow surveys are conducted in cooperation with the Bureau of Agricultural Engineering and with other Federal and non-Federal agencies. Extensive data are now published by the Weather Bureau for the Columbia and Colorado River Basins and for other sections of the Western States.

Research work in connection with shielded snow gages of the storage type has been carried on at Salt Lake City, Utah, for the past several years. Future plans include extensive research in snow hydrology and the development of methods to estimate quantitatively the run-off from the snow mantle.

PROGRESS IN MARINE METEOROLOGY

During the year good progress was made in the compilation of marine meteorological data, in the preparation of summaries for publication on the climates of oceanic and coastal areas, and in investigation of meteorological conditions as reported in observations taken on ships at sea. Much of this advance was made possible by the special project conducted at New Orleans, La., as described in last year's report.

THE MARINE PROJECT AT NEW ORLEANS, LA.

Under sponsorship and technical supervision of the Weather Bureau, the special project of the Works Progress Administration at New Orleans, La., brought nearly to completion the large task of compiling and summarizing more than 5,000,000 observations taken on ships at sea during the years 1880 to 1933, inclusive. Work was begun on the records for 1934 and 1935. Summary cards were prepared for practically all 5° squares of the navigable oceans to show, as averages for the whole period of years, the conditions of wind and weather and the frequency of fogs and gales. This work was near completion at the close of the year. These cards are to be preserved in filing cabinets so as to afford ready reference to weather records, by months, for any part of the oceans. The data on the summary cards are being used also to prepare monthly charts of the oceans showing climatic conditions graphically. This latter work was only partly completed at the end of the year.

A large amount of labor was required in this compilation. Ships' weather reports usually contain observations made on several days during a voyage, and they cannot be averaged in the same manner as land-station observations. It is necessary to transcribe the individual observations on separate slips and sort them, by ocean squares, before tabulating them or reducing them to punch cards. Copying, checking, sorting, and tabulating involved millions of individual operations.

Several special compilations were in progress at the end of the year. Tabulations of barometric-pressure distribution over the world by months, 1901–30, were begun. A beginning was made also in preparing maps of ocean-weather conditions in certain months in order to study their relation to dry and wet periods in the Southern Plains States. Another compilation of large proportions was in progress at the end of the year; when completed it will show the history of ocean temperatures (air and sea surface) in all 5° squares having sufficient observations to justify tabulation.

In addition to marine observations, considerable progress was made in treating other classes of data. The largest operation in this phase of the project is the tabulation of rainfall records of the United States on a weekly basis, not yet completed.

PUBLICATION OF WEATHER SUMMARIES IN THE AID OF MARINE NAVIGATION

All meteorological information on the Pilot Charts and in other publications of the Hydrographic Office for the benefit of navigators is supplied by the Weather Bureau. During the year meteorological chapters contained in Sailing Directions of the Hydrographic Office were rewritten as the volumes in this series were revised. Text and tables were compiled and furnished for publication during the year for the volumes pertaining to the China Sea, the eastern part of the Caribbean Sea, and the west coast of Mexico and Central America. Similar manuscripts, including upper-air data, were completed for publication in Naval Air Pilots of the West Indies and Central America.

Revision of the weather summaries, wind roses, and frequencies of fogs and gales shown on the Pilot Charts of the North Pacific Ocean was begun prior to the end of the year. Publication of new data will begin with the North Pacific Pilot Charts of January 1938. This revision has been needed by navigators for many years but was not feasible until the data were compiled in the New Orleans project previously mentioned. A revision of the meteorological chapters of a new Hydrographic Office edition of The Practical Navigator, by Nathaniel Bowditch, was also accomplished during the year.

The monthly publication, Weather on the Oceans, a separate of the Monthly Weather Review, which is published by the Weather Bureau, contained during the year several special articles of interest to the mariner, chiefly on storms at sea.

RESEARCH IN MARINE METEOROLOGY

The determination of temperature normals of the sea surface of the Gulf of Mexico, the Caribbean Sea, and the western North Atlantic Ocean by months was nearly completed during the year, and charts showing the normals are being prepared for publication as an aid to Weather Bureau forecasters and for the information of private organizations interested in conditioning of ships' cargoes. A large number of thermograms from ships were edited, annotated, and prepared for use by research students in oceanography and meteorology. Several thousand water-temperature observations transcribed from ship reports were sorted and filed by months and by 1° squares for use in temperature-history studies. From this compilation, charts showing diurnal march of air and water temperature in the Gulf of Mexico, Caribbean Sea, and adjacent North Atlantic waters were prepared. An intensive study of ships' weather reports from North Pacific waters, with particular reference to frontal meteorology, was carried on during the year, with the object of improving weather reports from that area.

Similar studies of ships' reports in other areas gave further aid in the formulation of revised instructions for marine meteorological observers, the supply of the previous edition of these instructions, issued in 1929, being exhausted. The manuscript for the revised edition (Circular M, sixth edition) was prepared during the year and was sent to press at the close of the year.

The new instructions, which provide for more detailed and precise observations than the old, are based on the most recent specifications of the International Commission for Synoptic Weather Information. Special attention is devoted to the proper method of describing the weather at time of observation, so that the true thermodynamic state of the atmosphere may be known. Likewise the proper procedures for obtaining air and sea-surface temperatures are given in considerable detail in an attempt to increase the accuracy of these observations, which in many cases have been found to be quite unreliable.

Another result of the study of average weather conditions on the oceans was the completion of a manuscript for a publication on the weather of the North Pacific Ocean for the information of ocean travelers. This publication, Average Conditions of Wind and Weather, North Pacific Ocean, is now in press. A similar publication for North Atlantic waters (including the Gulf of Mexico and the Caribbean Sea) was issued in 1936.

The cooperation of the Bermuda Biological Station was secured in servicing sea-water thermographs on two steamships voyaging between New York and Bermuda. These records are used in meteorological and oceanographic studies.

IMPROVEMENT IN MARINE BAROMETRY

The Weather Bureau has no funds for furnishing standard instruments to its marine observers, hence it must enlist the aid of shipmasters and shipowners

in improving their own instrumental equipment. Owing to the friendly attitude of marine interests, there has been further success in securing replacements of defective instruments, thus yielding an increasing degree of accuracy in marine weather observations, an important factor in weather forecasting. During the year ended June 30, 1937, defective aneroid barometers were replaced on 68 reporting ships, and action by the Weather Bureau to secure further replacements is under way.

HURRICANE WARNING SERVICE

The hurricane-warning service of the Bureau also was strengthened during the fiscal year by an inspection of meteorological stations in the Bahamas. Reports from a limited number of these stations are transmitted daily to the Weather Bureau and from the others in the group when a tropical storm is in the vicinity. The accuracy of such reports is, therefore, of vital importance in the successful forecasting of storms approaching the Florida coast from the east. The inspection by a Bureau official was arranged through cooperation with the Government of the Bahamas and was carried out by use of a United States Coast Guard seaplane. Fourteen of the twenty stations on the islands were visited. A thorough check was made of the instrumental equipment at each of these stations. Defective instruments were replaced and additional equipment supplied where needed. Instructions in observational work and care of instruments were given, and comparative barometer readings were made and corrections furnished. Preliminary arrangements were also made for obtraining reports of tide and swell from stations favorably situated for the purpose.

HURRICANE INVESTIGATIONS

The Bureau, in cooperation with the Massachusetts Institute of Technology, equipped four stations (Jackson, Miss.; Maxwell Field (Montgomery), Ala.; Augusta, Ga.; and Habana, Cuba) with approximately 120 meteorographs and sounding balloons to be released during the passage of a hurricane. The signal for the release of the balloons was to be given by the Bureau forecasters in Washington. The balloons were to be released at intervals of one-half hour or greater, depending on the position of the station with reference to the storm center and its rate of movement; the closer to the center and the greater the rate of movement the shorter were to be the intervals. Such observations would provide valuable pressure, temperature, and humidity data, portraying the vertical structure of these storms, and would furnish important information in aid of forecasting. Since no hurricane passed the stations, the balloons were not released. Preparations have been made for a similar project this year, with an increase in the number of stations. The new arrangements provide for the following observing points: Vicksburg, Miss.; Maxwell Field (Montgomery), Ala.; Macon, Ga.; Raleigh, N. C.; and two mobile stations in Cuba. The stations are selected so that they lie near the usual paths of hurricanes and are sufficiently far from the coast so that the instruments will fall on land after the balloons burst. The instruments are tagged, and the finder is requested to return them to the Weather Bureau, for which a payment of $3 is made.

HORTICULTURAL PROTECTION

The horticultural-protection service is a highly specialized and important activity of the Weather Bureau, conducted as an aid in frost protection, chiefly in intensively cultivated subtropical sections where during the winter season many hundred millions of dollars' worth of citrus groves and winter truck farms vie with the frost for existence. During the spring blossoming period service is maintained also in various deciduous-orchard sections of the far West. The problem of reducing or preventing annual frost losses is one of primary concern to thousands of fruit growers, as the work and expense of bringing costly groves and orchards to maturity may be rendered a total loss in a single night of severe frost. Moreover, one freeze may wipe out the profits of several years, with disastrous results not only to the individual but to the entire community.

Effective measures of frost control have been devised. However, these require large expenditures for grove-heating equipment and fuels and at times require the services of much additional emergency labor. The efficiency of these frost-control measures lies in organization and preparedness

so that when warning is given the whole frost-fighting machine quickly can be brought into action and remain alert until all danger is past. Since the weather, especially critical temperatures, is the sole factor involved in the frost hazard, detailed forecasts of temperature at numerous stations spread intensively over local areas are indispensable for efficient and intelligent use of grove-heating equipment.

The forecast information, supplied by the horticultural-protection service, enables the growers to plan their heating work well in advance so as to eliminate entirely all periods of useless operation and keep the frost-fighting expense at a minimum. Experience has shown that large-scale grove heating seldom succeeds when attempted without adequate weather information and timely forecasts.

THE PACIFIC STATES

Heavy crop losses during freezes led California citrus growers to burn coal in crude baskets, made of chicken wire hung in the trees, as early as 1897. When the Weather Bureau's horticultural-protection work began, in 1917, oil-burning heaters had largely replaced those designed for burning solid fuel, but frost-protection methods had progressed but little along other lines, either in California or in other Pacific States, where heaters had come into use to protect deciduous fruits. Cheap, inaccurate thermometers, heaters with too small capacity to burn through the night, oil containing an excess of asphaltum, water, and sulphur, lack of knowledge of critical temperatures, ignorance of the principles of orchard heating, and, most important of all, lack of detailed, accurate temperature forecasts, had caused so many failures to save crops that orchard heating had come into general disfavor. The acreage equipped with heaters was steadily declining at the time the Weather Bureau's horticultural-protection work began.

The first few years of this project were devoted almost entirely to experimental work. New types of thermometers were designed, especially suited for orchard-heating operations, and made available at reasonable prices through growers' cooperative purchasing agencies. Arrangements were made to service and check these for accuracy at the beginning of each frost season. The principles involved in orchard heating were explained at meetings of citrus-fruit growers and also in published articles and bulletins. Experiments showed definitely that smoke, which theretofore had been credited with saving crops, was of minor importance. Critical temperatures for various fruits, buds, and blossoms were determined. Temperature surveys were made in different fruit districts to show locations of colder and warmer areas on frosty nights, and the absurdity of claims for "frostless belts" was demonstrated. Influence of cover crops on orchard temperatures was investigated. Frost marking of pears and apples was studied. Improved and standardized orchard-heater oils were developed in cooperation with oil companies, and improvements in design of lighting torches were suggested. Various frost-protection methods were investigated and tested; but it was soon found that orchard heating, properly handled, would protect trees and crops during the most severely cold periods likely to occur, and that no other method was as economical, practical, or dependable.

In the fruit frost service, localized daily forecasts of minimum temperature, local wind conditions, temperature inversion or "ceiling", the time heating should begin, and other similar information are given in most cases directly to the public by radio. These forecasts contain every item of information needed to assist the grower in protecting his crop from frost. California citrus acreage equipped with orchard heaters has increased steadily during the last 15 years to approximately 75,000 acres in 1937.

THE JANUARY FREEZES IN CALIFORNIA

The freezes of January 1937, which broke all records for low temperatures and duration of freezing weather in southern California, afforded opportunity for a remarkable demonstration of the effectiveness of orchard heating. Despite utterly inadequate storage of heating fuel, damage to crops and trees was almost unbelievably small in the light of experience in previous freezes far less severe. Damage in groves properly equipped for heating was negligible. In districts where a large percentage of the orchards were adequately heated, the scattered intervening orchards not equipped with heaters received protection from the neighboring heated groves and showed little or no damage. This effect of "mass heating" was the outstanding feature of the cold period.

Tree damage was confined almost entirely to districts in which there was little or no orchard heating and to orchards located on the windward fringes of well-protected districts. The heaviest damage occurred in sections normally warm, in which protection had been considered unnecessary, while the normally colder areas, well equipped for protection, suffered practically no injury. The lowest temperature recorded in a citrus grove, 13.5° F., was in a district normally warmer than the average in which there were no orchard heaters. In an unprotected grove in a normally colder district, in which approximately 90 percent of the orchards were heated, the lowest recorded was 20.3°. This shows the effect of mass heating.

Approximately 81,900,000 gallons of oil were burned during the freezes, costing about $4,000,000. Other costs of protection are very difficult to estimate. Growers who saved their crops actually profited by the freeze, since better prices received for sound fruit far more than paid the heating costs.

LARGE SAVINGS FROM WEATHER BUREAU WARNINGS

Warnings well in advance of both freezes made possible the mobilization of all agencies for the transportation of additional orchard-heater fuel from refinery storage to the citrus districts. On the strength of these, for example, one railroad company brought on fast train schedule more than 150 oil-tank cars to southern California from the San Francisco Bay district. Since fuel supplies ran dangerously low before the end of the cold period, despite the most heroic efforts on the part of the transportation companies, a few growers who had spent large sums for protection lost their crops on the last night because of inability to secure fuel. The freeze warnings of the Weather Bureau are credited with the prevention of a catastrophe. Cooperation of a powerful radio station made it possible to talk directly to the growers at critical times.

The California citrus crop returns to the State in excess of $100,000,000 per year, and advance warnings of dangerous temperatures have resulted in saving sufficient fruit in one night to pay the cost of the horticultural-protection project for a generation. Frost protection benefits consumers through assuring a larger supply of good fruit in a freeze year and by stabilizing prices.

Recipients of the service carry approximately one-half the cost of the Weather Bureau's horticultural-protection work, insuring local interest and guarding against the continuation in any district where its practical value is not demonstrated continuously. In recent years localized forecasts have been made in deciduous-fruit districts in connection with spraying operations, and of weather unfavorable for fumigation, spraying, or dusting operations during the spring, summer, and autumn in southern California citrus districts.

SERVICE IN FLORIDA

Following the disastrous Florida freeze in December 1934, funds were provided by the Federal Government and the State of Florida to establish a cooperative horticultural-protection service in that State. During the winter of 1935–36 five districts were organized in the west-central portion of the peninsula, where there is heavy concentration of citrus plantings. Reports containing localized minimum-temperature forecasts and other information essential to protecting citrus and truck crops against frost damage were broadcast during the frost-danger period several times daily, on a staggered time schedule, by networks of important Florida commercial radio stations. Initial work was so well received that additional funds have been provided to extend the service. During the coming winter most of the Florida Peninsula will be covered with an organization of additional horticultural-protection field districts.

Service at present is largely of a pioneer nature, and the educational and research activities have been stressed. Research work to determine the critical temperatures of citrus fruits and garden truck commercially grown in the State is in progress; also to determine the efficiency of grove heating under Florida weather conditions, using heaters designed to burn local fuels, as well as with open wood fires quite commonly used. Studies of temperature inversions are being prosecuted, using for this purpose high steel towers and also ground stations located on hill slopes. Growers' meetings at which the principles of grove heating are discussed are being held so as to direct the local work in frost protection along lines which experience and experiment have proved to be effective and safe.

LIBRARY

The Weather Bureau library has the largest collection of meteorological literature in the world. It is extensively used by the technical staff of the Central Office, and by the field stations of the Bureau, as well as other governmental organizations and private institutions. Of late the demands on the library have increased because of both the natural growth of the Weather Bureau service and the increasing interest in meteorological research. Nearly 200 periodicals are received by it, about 50 of which are purchased; the remainder are received by exchange with the Monthly Weather Review, or are gifts. Many of these periodicals deal solely with meteorology; all contain items of interest for meteorologists from time to time. The library also receives publications from meteorological services and institutes throughout the world. During the year just closed improvements were made in the reading-room facilities of the library.

Shortly after the late C. F. Talman took charge of the library in 1908, he started the compilation of a dictionary of meteorological terms. His material for this dictionary consists of cards with much useful information to meteorologists. He added to this card collection continuously. Even in its present unpublished form the collection is of great value to the Weather Bureau, but its publication would enable the entire meteorological world to benefit from it. It was the plan of the Weather Bureau to relieve him of charge of the library in July 1936, thus to allow him time to get this large and important card collection in shape for publication in book form. His death, however, made it necessary to appoint a committee consisting of officials from the library and Meteorological Research Division to study ways of getting this material in shape for publication, and a good beginning has been made. The library continues to add new words to this card file as they are found in the literature, so that when this monumental Meteorological Dictionary and Reference Book is published it will be up to date. It will give etymologies, definitions, literature references, and discussion of all the terms used in meteorology.

THE YEAR'S WEATHER

Following the severe drought and high temperatures extending through the spring and summer of 1936, described in last year's report, substantial rains during the latter part of August relieved droughty conditions over many northern and eastern sections of the country. The moisture benefited late crops, revived pastures, and improved the condition of the soil for plowing and for seeding of winter grains.

September, in marked contrast to the summer months, had more than normal rainfall over most sections of the country east of the Rocky Mountains, with the monthly totals outstandingly large from Texas and New Mexico northeastward over the central valleys. Texas, Oklahoma, Missouri, and Iowa had more than double the monthly normals and many other States substantially more than the usual September rainfall. However, a considerable area in the Northwest continued relatively dry.

THE AUTUMN

For the 3 autumn months, September, October, and November, precipitation was above normal over a wide belt extending from the Southwest northeastward to and including the Ohio Valley and lower lake region. These rains were opportune and very favorable for the seeding, germination, and early growth of wheat, though at the beginning of the winter additional moisture was needed in the western portion of the Wheat Belt. From the Mississippi Valley eastward the autumn season brought mostly ample moisture for the needs of vegetation.

THE WINTER OF 1936–37

There were no marked abnormalities in December or February weather. However, January was characterized by marked extremes of both temperature and precipitation in different portions of the country. There were excessive rainfall and disastrous floods in the Ohio Valley and two severe freezes in the far West, especially in southern California, where heavy damage to citrus fruits and truck occurred. At the same time, abnormally warm weather prevailed in the more eastern States, especially the Southeast, where all vegetation became abnormally advanced, in many cases fully a month ahead of an average season.

The winter brought above normal precipitation to nearly all sections of the country, with heavy snow in the Central-Northern States. For the 3 months, December, January, and February, precipitation was above normal everywhere, except in South Dakota, Nebraska, Oklahoma, Texas, and New Mexico, with many States having more than one and a half times the normal for the season.

THE SPRING

The spring of 1937 began with plenty of moisture in the soil nearly everywhere east of the central Great Plains—too much in places—while winter snows in the higher western mountains had stored ample moisture rather generally for summer irrigation. The greatest snowfall reported for the period from December to April was 642 inches at Paradise Inn, Wash.

For the 3 spring months, March, April, and May, rainfall was much heavier than during the spring of 1936 throughout the Mississippi and Ohio Valleys and in the northern Great Plains. However, a belt extending from eastern New Mexico and western Texas northward to Canada had very little precipitation, and by the middle of May severe drought prevailed in most of this area. The latter part of May and the first part of June brought heavy rains to these sections, which temporarily relieved droughty conditions, but a generally dry period followed, and by the middle of July rain was again needed in most of the area. The percentage of normal precipitation in the different States from September 1936 to June 1937 is given in table 1.

TABE 1.—*Percentage of normal precipitation, by States, September 1936 to June 1937*

State or section	1936				1937					
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
Alabama	85	77	52	145	175	94	76	164	110	86
Arizona	128	106	99	166	153	131	180	19	100	157
Arkansas	141	160	81	125	294	63	63	65	71	120
California	35	99	4	137	81	170	154	86	24	200
Colorado	124	100	42	103	101	126	110	55	63	136
Florida	65	130	70	109	65	164	140	174	84	86
Georgia	123	145	50	148	166	109	76	193	63	95
Idaho	56	24	8	94	88	150	78	178	45	138
Illinois	187	118	83	131	261	70	39	142	78	124
Indiana	142	163	117	101	321	77	39	143	86	121
Iowa	190	71	41	131	210	96	94	117	99	81
Kansas	172	92	14	137	212	67	115	39	84	82
Kentucky	121	128	101	114	361	70	30	111	99	106
Louisiana	70	68	97	91	180	60	105	74	69	115
Maryland-Delaware	74	112	39	175	233	104	59	176	101	131
Michigan	155	111	58	107	123	102	30	145	74	103
Minnesota	72	35	86	185	193	130	70	185	121	76
Mississippi	69	67	80	123	228	74	73	84	77	107
Missouri	209	124	73	138	287	69	52	104	80	102
Montana	70	58	36	112	88	106	81	80	26	106
Nebraska	83	24	36	99	161	32	128	47	74	86
Nevada	71	136	14	185	124	168	94	62	55	47
New England	87	130	59	188	127	82	102	117	142	126
New Jersey	122	100	37	172	176	63	73	129	82	125
New Mexico	173	52	72	86	68	130	164	44	259	165
New York	93	138	91	119	166	87	84	121	110	142
North Carolina	119	184	82	165	215	101	47	166	52	90
North Dakota	73	20	55	83	144	107	51	138	75	121
Ohio	107	157	97	84	312	67	49	127	100	168
Oklahoma	256	97	25	102	152	30	101	68	72	95
Oregon	69	7	5	94	96	132	95	209	66	273
Pennsylvania	63	113	85	133	196	78	58	161	87	109
South Carolina	110	203	76	154	190	100	66	219	57	100
South Dakota	44	31	124	64	150	65	129	78	78	104
Tennessee	101	142	85	141	312	81	39	96	115	87
Texas	240	93	60	86	111	28	134	34	61	88
Utah	54	156	62	195	142	140	118	77	102	72
Virginia	105	125	46	165	253	102	42	181	73	120
Washington	76	23	12	118	56	142	84	216	62	283
West Virginia	62	140	92	120	235	107	52	117	89	115
Wisconsin	95	91	49	141	189	171	36	132	84	68
Wyoming	62	93	70	96	82	126	97	94	75	146

OHIO AND LOWER MISSISSIPPI VALLEY FLOODS OF JANUARY AND FEBRUARY 1937

An outstanding feature of the year's weather was the unprecedented rainfall that produced disastrous floods in the Ohio and lower Mississippi Valleys, in January and February 1937. These floods were caused by a prolonged period of heavy to excessive rain over the Ohio Basin, which began on December 26, 1936, and continued with little interruption until January 25, 1937.

Throughout most of this period there was a pronounced stagnation of air masses, with persistent high pressure over the Bermuda-Florida area and also over the Northwestern States, with a trough of low pressure between them, centering over the Ohio Valley. This pressure distribution resulted in an almost continuous northward and northeastward movement of great quantities of moisture-laden tropical air over the lower Mississippi and Ohio Valleys, while air masses of polar origin moved southward, almost continuously, over much of the western half of the United States. The extremely heavy rainfall over the Ohio Valley and portions of adjacent areas was, in general, caused by the persistent trough of low pressure being so located, with relation to the very deep areas of high pressure on both sides, that the line of contact between the warm, moist air from southerly regions, and the cold air of polar origin lay somewhere over the Ohio Valley much of the time. The rapid forcing aloft of the moist air of tropical origin resulted in excessive precipitation over an area the major axis of which closely paralleled the Ohio River.

Although this was a midwinter flood, accumulated snowfall was not a contributing factor; practically all of the water came from current rain. The ground was thoroughly saturated, and lack of vegetation contributed to maximum run-off possibilities. During the first half of the period the rainfall was sufficiently heavy to put the lower Ohio and its lower tributaries into moderate flood. On the main stream, flood stage was reached first at Cairo, Ill., on January 9; at Evansville, Ind., January 10; and at Cincinnati, Ohio, January 18. During the second half—from the 13th to 24th, inclusive—rainfall was exceedingly heavy, the area of greatest intensity being located along the Ohio River from the vicinity of Cincinnati to its mouth, extending somewhat south of the river near the mouth, and into Arkansas.

This concentration of excessive rainfall resulted in the highest river stages of record in the main stream from immediately below Point Pleasant, W. Va., to the mouth at Cairo, Ill., and in the lower Mississippi River from Cairo to the mouth of the Arkansas River. At Cincinnati the crest stage of 80.0 feet was 8.9 feet higher than the crest of the great flood in February 1884, which stood as the record stage at that point for more than 100 years, and at Louisville the crest was 10.4 feet higher than the record stage in that year. It is significant to note that record-breaking stages occurred in the lower portions of many Ohio tributaries, while in the upper reaches flood stages did not occur.

One of the characteristics of this flood was the long duration of high stages. The river remained above flood stage at Cairo and Paducah 48 days; Evansville, 39 days; Louisville, 22 days; and Cincinnati, 17 days. In the upper reaches of the river the fall was rapid after the passage of the crest but much slower in the lower portions.

The flood-forecasting service of the Weather Bureau functioned in a highly satisfactory manner. From the beginning of the rain period river-stage forecasts and flood warnings were issued regularly at the various forecast centers and given wide distribution. All flood forecasts were promptly relayed to the national headquarters of the American Red Cross, where they were used in formulating plans for relief activities. On account of the long continuation of excessive rainfall the time interval in the final crest-stage forecasts for the river above Cincinnati was necessarily of short duration, as the river ceased to rise in that section within 30 hours after the rain ended. Below Cincinnati accurate final crest-stage forecasts were issued for extended periods ranging from 3 days at Louisville, 6 days at Evansville, 9 days at Cairo, and 14 days at Memphis, to 31 days at New Orleans.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

REPORT OF THE DIRECTOR OF PERSONNEL, 1937

United States Department of Agriculture,
Office of Director of Personnel,
Washington, D. C., September 30, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: Herewith I submit a report of the work in the Office of Personnel for the fiscal year ended June 30, 1937.

Sincerely yours,

W. W. Stockberger, *Director.*

Personnel work in the Department is visualized as an activity the primary function of which is essentially one of service to the operating agencies. The individual worker is regarded as the critical factor conditioning the performance of functions for which the administrative officials in the operating agencies are responsible. It follows, therefore, that effective personnel work must go far beyond orderly procedures and record keeping. It must be concerned in the selection, placement, training, and promotion of employees, for their safety and welfare, and for whatever else will increase the satisfaction they derive from their work and contribute to the greatest efficiency obtainable from them.

The ever-widening scope of the activities of the Department with resultant responsibility in relation to the economic and social structure of the Nation emphasizes the need for systematic planning to develop the highest grade of executive and administrative personnel, to devise means for increasing the attractiveness of positions at the higher levels of authority and responsibility, and to check the flow of experienced personnel into industry and private activity which inevitably occurs with every rising tide of prosperity.

The opportunity for a scientific approach to its problems is no less in personnel work than in the physical and biological sciences. Scientific studies of adequate personnel data should yield results of primary importance in determining the factors which condition the socially useful behavior of employees. Personnel research should be the guiding influence in shaping personnel policies, in the exploration of the motivation of our human resources, and in the direction of human effort toward the attainment of the objectives of our organization.

IN-SERVICE TRAINING

There is a growing awareness of the importance of training within the service, and constructive training programs deserve the sympathetic support of all who are concerned for the improvement of performance and for raising the level of competence in the Department. Some of the more general aims of training are to acquaint new employees with the purpose and work of the agency in which they are employed, to increase skill in the performance of the work to which they are assigned, to discover employees fitted for advancement, and to prepare them to undertake more difficult or more responsible assignments of duties and responsibilities. Fruitful results should follow wider acceptance of the dogma that the public interest will be enhanced through carefully planned programs of training designed to develop latent abilities of employees and to inculcate in them habits for continuing self-education. The formal or academic phases of training may well be left to the schools, colleges, and universities, and efforts focused on types of training designed (1) to increase proficiency in selected skills, and (2) to promote understanding of the concepts and objectives of specialized lines of work and an appreciation for the interrelationships which must be observed in fitting them into the frame of a major activity. Progress toward these ends would be materially hastened through the establishment of a central division of training to coordinate existing training work and to aid in the development of new and needed programs for additional training.

24669—37

SAFETY WORK

Late in the year funds were authorized for safety work and the Division of Safety was accordingly established in this Office. The chief of this Division will make detailed studies of the accident problem in the Department, install a uniform system of recording and reporting accidental injuries to employees, and cooperate with the interdepartmental safety council and with representatives from each of the bureaus in the development of safety work in the Department.

APPOINTMENTS, SEPARATIONS, AND PROMOTIONS

There were 60,229 employees serving under formal appointment by the Secretary of Agriculture on June 30, 1937, as compared with 53,522 on June 30, 1936, or an increase of 6,707 during the fiscal year. The number of employees in the Soil Conservation Service was increased from 5,635 to 8,111 by June 30, 1937, a net gain of 2,476. The Resettlement Administration was transferred to the Department of Agriculture on January 1, 1937, and formal appointments were issued to the Washington personnel, which on June 30, 1937, numbered 2,329. A number of Emergency Conservation Corps workers in the various bureaus of the Department were given formal appointments during the year. The increase in the number of employees of the Forest Service holding appointments from 5,558 to 7,383, a net gain of 1,825, was largely due to these E. C. W. appointments. The increase in the Soil Conservation Service, the addition of the Resettlement Administration and the formal appointments of a large number of E. C. W. employees, accounts for practically all the gain in the personnel of the Department during the year. It is interesting to note that on June 30, 1932, there were 27,350 persons holding formal appointments in the Department of Agriculture, as compared with 60,229 on June 30, 1937.

The personnel of the Agricultural Adjustment Administration was decreased from 5,493 as of June 30, 1936, to 4,394 by June 30, 1937, a reduction of 1,099.

There were 16,447 employees in the field service of the Resettlement Administration on June 30, 1937, but these figures are not included in the computations because these employees did not hold formal appointments by the Secretary of Agriculture.

Personnel data for the last 5 years are shown in table 1.

TABLE 1.—*Personnel activities of the Department of Agriculture, 1933–37*

Year ended June 30	Employees on rolls of Department			Field stations	Employees appointed	Separations from the Department
	Departmental service	Field service	Total			
1933	5, 521	[1] 21, 023	26, 544	1, 451	3, 915	4, 721
1934	10, 032	[1] 28, 591	38, 623	1, 451	[2] 31, 434	[3] 19, 355
1935	11, 437	[4] 32, 643	44, 080	1, 864	[5] 29, 092	[6] 23, 635
1936	11, 382	[7] 42, 140	53, 522	1, 864	[8] 30, 634	[9] 21, 192
1937	[10] 13, 371	[11] 46, 858	60, 229	2, 924	[12] 34, 561	[13] 27, 854

[1] Includes 80 in Foreign Service.
[2] Includes 11,667 in Agricultural Adjustment Administration.
[3] Includes 6,647 in Agricultural Adjustment Administration.
[4] Includes 52 in Foreign Service.
[5] Includes 8,249 in Agricultural Adjustment Administration.
[6] Includes 7,455 in Agricultural Adjustment Administration.
[7] Includes 52 in Foreign Service.
[8] Includes 5,186 in Agricultural Adjustment Administration.
[9] Includes 5,821 in Agricultural Adjustment Administration.
[10] Includes 2,329 in Resettlement Administration.
[11] Includes 88 in Foreign Service.
[12] Includes 1,336 in Agricultural Adjustment Administration.
[13] Includes 2,435 in Agricultural Adjustment Administration.

On June 30, 1937, there were 1,634 collaborators serving without compensation who are not included in table 1.

The turn-over of permanent employees during the year was 5.12 percent, as compared with 6.88 percent during the preceding year, 7.19 percent during 1935, 10.63 percent during 1934, and 3.88 percent during 1933.

During the year there were 11,960 promotions, as compared with 10,815 in 1936, and 3,764 in 1935. Promotions during 1935 were from grade to grade only, under the Economy Act of June 30, 1932, while in 1936 and 1937 administrative promotions or promotions within the grade were possible, and the number given for these fiscal years includes promotions both within the grade and from grade to grade.

RECORD OF LEAVE

Employees were allowed annual leave at the rate of 15 days for the full year in 1935, together with the leave accumulated from 1933 and 1934. Data are given in table 2 to show the distribution of the annual and sick leave used in Washington in the calendar year 1935. Men and women in Washington averaged 14.4 days annual leave, as compared with 11.9 days in 1934. Employees in the field averaged 11.4 days, as compared with 10.2 days in the previous year.

TABLE 2.—*Distribution of employees in Washington according to number of days of annual and sick leave used, calendar year 1935*

Days taken (number)	Annual leave		Sick leave		Days taken (number)	Annual leave		Sick leave	
	Employees [1]	Total days taken	Employees [1]	Total days taken		Employees [1]	Total days taken	Employees [1]	Total days taken
	Number	*Number*	*Number*	*Number*		*Number*	*Number*	*Number*	*Number*
0	287	0	1,617	0	17	612	10,404	133	2,261
1	93	93	580	580	18	480	8,640	110	1,980
2	94	188	588	1,176	19	421	7,999	96	1,824
3	111	333	475	1,425	20	373	7,460	91	1,820
4	112	448	462	1,848	21	244	5,124	77	1,617
5	123	615	399	1,995	22	206	4,532	85	1,870
6	181	1,086	352	2,112	23	174	4,002	65	1,495
7	185	1,295	316	2,212	24	140	3,360	66	1,584
8	193	1,544	328	2,624	25	105	2,625	67	1,675
9	262	2,358	274	2,466	26	78	2,028	60	1,560
10	261	2,610	264	2,640	27	66	1,782	64	1,728
11	327	3,597	267	2,937	28	54	1,512	58	1,624
12	350	4,200	294	3,528	29	31	899	138	4,002
13	461	5,993	173	2,249	30 [2]	47	1,488	490	14,700
14	626	8,764	209	2,926					
15	1,146	17,190	163	2,445	Total	8,502	122,713	8,502	75,159
16	659	10,544	141	2,256					

[1] Not including employees on temporary status who were not entitled to leave.
[2] 30 and over for annual leave only.

Average number of days annual leave, 14.4; average number of days of sick leave, 8.8.

The average sick leave used by employees in Washington in 1935 was 8.8 days, an increase of 1.3 days over 1934, and an increase of 1.2 days over the average for the previous 8 consecutive years. Only 5.8 percent of the employees took the maximum amount of sick leave. There were 1,741 employees who used more than 15 of the allowable 30 days of sick leave. The total number of days of sick leave taken by this group was 41,996. Hence 20.5 percent of the employees used 56 percent of the total sick leave taken.

In the field, where the limit of sick leave was 15 days, the average sick leave taken during 1935 was 2.7 days, as compared with the past 8-year average of 2.9 days. Ten and one-half percent of the employees in the field took 19,185 days of sick leave and 89.5 percent used only 18,276 days.

During the calendar year 1935, 19 percent of the employees in Washington did not take any sick leave. In the field for the same year, only 5.2 percent took the maximum amount and 52 percent took none. The past 8-year average of employees taking the full amount of sick leave is 5.5 percent for Washington and 6 percent for the field; whereas 25 percent of the employees in Washington and 52 percent of the field force used no sick leave.

WORK INCIDENT TO APPOINTMENTS, TRANSFERS, AND PROMOTIONS

During the year, 760 formal applications for civil service positions were received from all sources and circulated throughout the Department, as compared with 413 during 1936.

It has always been the general policy of the Department of Agriculture to fill vacancies by promotion of employees in the service of the Department whenever possible; but on May 26, 1937, a procedure for carrying out this policy was placed in effect by the issuance of instructions to all bureaus and offices, with respect to the filling of permanent positions in Washington. The plan announced provided for the advertisement of vacancies on bulletin boards and the circularization of appropriate notices throughout the Department. During June, 24 vacancies were announced and 133 applications were received from employees. These applications were forwarded for consideration to the office or offices where the vacancies existed. Notwithstanding the short time this procedure has been in operation, it has demonstrated its value in emphasizing the policy of filling vacancies from within the service.

Personnel matters which required contacts with the Civil Service Commission, and the procurement of authorities for personnel changes are shown in table 3.

TABLE 3.—*Personnel changes in the Department of Agriculture, 1933–37*

Item	1933	1934	1935	1936	1937
Certificates from register	74	1,510	1,648	1,948	1,425
Reinstatement certificates	27	481	416	481	442
Certificates for change in status	108	254	910	1,388	2,166
Transfer certificates	69	465	220	452	267
Authorities for temporary appointments	94	4,848	740	771	4,700
Authorities for extensions of temporary appointments	66	4,031	1,466	[1] 270	941
Authorities for extensions of suspensions	6	3	2	3	7
Civil-service examinations requested	7	29	110	124	65

[1] The material reduction in this item under previous years may be accounted for by the fact that the various bureaus and offices of the Department have been filling more or less temporary vancancies for duration of work by probationary appointments in which cases no extensions of temporary appointments are involved.

RETIREMENTS

During the year 43 employees in the professional service were retired, 29 because of reaching the age for retirement, 8 on account of disability, 4 having rendered 30 or more years of service and retiring under the optional provision upon reaching the age 2 years earlier than the compulsory age limit, and 2 incident to reduction in force. The average annuity for the entire group was $1,049.04.

In the subprofessional service 62 employees were retired, 31 on account of age, 20 because of disability, and 11 by optional retirement. The average annuity for this group was $1,027.02. The 38 retirements in the clerical, administrative, and fiscal service included 14 on account of age, 20 because of disability, 3 by optional retirement, and 1 by reduction in force. The average annuity was $887.82. Of the 10 retirements in the custodial service, 4 were separated on account of age, 5 for disability, and 1 by optional retirement. In this group the average annuity was $708.79.

The amount of annuity is based on salary and length of service. The minimum annuity granted was $187.92. There are two types of annuity, either of which may be chosen by the employee. One is known as life annuity and provides for the payment to the employee's estate of the unexpended balance to his credit in the retirement fund, in the event of his death; the other is designated increased annuity with forfeiture; that is, upon the death of the employee the unexpended balance remains in the retirement fund. During the year, the largest life annuity was $1,323.48, and the largest increased annuity with forfeiture was $1,442.64.

Continuances in the service beyond retirement age were granted to a principal veterinarian in the Bureau of Animal Industry; a principal agronomist, a principal pathologist, and a senior pathologist in the Bureau of Plant Industry; a chief accountant and auditor in the Office of the Director of Finance; a senior forester in the Forest Service; and a regional law officer in the Office of the Solicitor.

There were 384 applications for service credit and 1,024 applications from employees separated from the service for refund of their retirement deductions were certified to the Civil Service Commission for adjudication. In addition, 3,302 master retirement record cards No. 2806 were completed and forwarded to the Civil Service Commission for employees who resigned, transferred to other establishments, or were separated for other reasons.

Figures showing the retirements for the last 5 years are given in table 4, and the average annuities paid in the various groups are shown in table 5.

TABLE 4.—*Number of employees retired, 1933–37*

Year ended June 30	Annuity retirements in class				Disability retirements in class				
	Professional	Subprofessional	Clerical, administrative, and fiscal	Custodial	Professional	Subprofessional	Clerical, administrative, and fiscal	Custodial	Cases disposed of
1933	81	132	22	28	9	23	19	15	329
1934	51	63	58	24	12	12	28	11	259
1935	46	65	24	12	10	14	29	5	205
1936	29	50	18	6	11	19	18	3	154
1937	35	42	18	5	8	20	20	5	153

TABLE 5.—*Averages of the annuities in the various groups, 1933–37*

Group	1933	1934	1935	1936	1937
Professional and scientific	$1,114.04	$1,102.22	$1,039.81	$1,068.59	$1,049.04
Subprofessional	1,012.91	946.81	960.08	990.43	1,027.02
Clerical, administrative, and fiscal	963.67	946.83	826.35	865.08	887.82
Custodial	695.98	757.72	728.50	654.05	708.79

CLASSIFICATION OF POSITIONS

The classification staff operating under the Classification Act of 1923, as amended, has continued to review new positions and duty changes resulting from the growth and reorganization of the Washington service; has expanded its information and aid to a greater number of tentative classifications of field positions; has continued to keep up-to-date organization charts of the various bureaus and offices of the Department and has assisted the bureaus in formulating new organization plans; has developed an in-service training course on classification techniques; has begun the preparation of a field classification manual; has started special studies on occupational groups with accompanying cross-section charts; has personally inspected a greater number of field stations; has attended and participated in national personnel meetings; and has rendered direct and constant service and advice to the bureaus in preparing an increased number of job descriptions, charts, and related classification matters.

A total of 6,339 appointments and changes in status in Washington employees were acted upon during the past year. The number recorded is slightly less than for the preceding year because of the invalidation of portions of the Agricultural Adjustment Act and the subsequent decrease in personnel. This in a way was counterbalanced by the addition of the Resettlement Administration, formerly an independent agency. In addition many cases were reviewed and returned without action. The number does, however, reflect all cases that involve change in duties, or an appeal for reallocation. Each of these involves a careful job analysis. There is a marked decrease in the number of appeals, as more attention is given each year to the individual and group needs of the employees.

A summary of this activity, insofar as it relates to the personnel in Washington for the past 5 years, is given in table 6.

TABLE 6.—*Appointments and changes in status of employees of the Department of Agriculture, 1933–37*

Year ended June 30	Appointments to new positions	Changes in duties	Changes to vacancies	Appeals	Total
1933	246	143	104	5	498
1934	5,561	1,274	2,329	15	9,179
1935	1,634	3,315	3,260	45	8,254
1936	1,905	3,698	2,145	45	7,793
1937	911	4,002	1,403	23	6,339

In addition to those shown in table 6, a large number of positions have been reviewed from the field service and tentative classifications assigned according to departmental standards. The volume of such transactions has been gradually reduced over the preceding year, as the reorganization of the Forest Service and the expansion of the Soil Conservation Service have now reached a near-normal level.

Individual and office surveys on duty assignments have been expanded during the past year, and have yielded data of value to the bureaus and to the central personnel office. Cross-section studies on grade levels, duty series for selected types of work, and special wage and occupational studies have been made as an aid in the solution of organization and salary problems. Data on wages and duties of unclassified positions have been accumulated. This information has helped in the solution of personnel problems, increased the efficiency of management through improved employee relations and morale, and resulted in financial savings to the bureaus. Studies have been made on certain lines of work and pay of non-Government employees operating under employee organizations, and the resulting recommendations have been of service in establishing fair and adequate wage scales for such workers.

Extensive inspections of field positions in the vicinity of Washington were undertaken and the foundations laid for maintaining standard wage and job assignments. Representative field offices of the Soil Conservation Service and Forest Service were visited in widely separated regions of the country and valuable classification information secured. Such inspections provide first-hand information that serves properly to evaluate the work performed, enables grade and salary adjustments to be made, encourages the employees, helps the supervisors with their more difficult cases, avoids duplication of work assignment, and provides material savings to the Department. Classification is primarily concerned with perpetuating the principle of equal pay for equal work.

During the past year a 6-week group study instruction course was offered to those concerned with classification matters in the bureaus. This was well attended and helped to increase the interest in the services of classification to the Department.

The staff is constantly called upon to render advice to bureau officials in questions of classification procedure, both in Washington and in the field. Trained assistants who are familiar with the entire Department structure conduct studies, visualize requirements, and render recommendations as to duty assignments, evaluation of responsibilities, job descriptions, job levels, wages, and related problems of organization. With the large number of employees in the field service, the materials collected from each field trip or office survey on wages, duties, and related facts are invaluable in maintaining fair and uniform standards of work and pay throughout the several agencies of the Department.

INVESTIGATIONS

During the year a total of 888 recommendations, most of which were for the imposition of disciplinary penalties on account of delinquency, misconduct, and fiscal and other irregularities, received consideration by the Division of Investigations. Eighty-seven personnel investigations and 22 miscellaneous investigations were conducted, and 3,580 Agricultural Adjustment Administration contracts were investigated.

A substantial number of the investigations resulted in the recovery of money due the Government from employees and others as a result of payments being made erroneously or of Government checks falling into the hands of persons other than the payees.

It is highly desirable that personnel investigations, involving delinquency, misconduct, and fiscal and other irregularities on the part of employees, be conducted with as little delay as possible, in order that corrective measures may be promptly taken with a view to eliminating from the service dishonest or otherwise undesirable employees. Prompt handling and settlement of such cases result in removing suspicion from honest employees, strengthening morale, aiding in the maintenance of proper discipline, and eliminating waste and inefficiency, all of which are essential to effective administration, efficient service, and just treatment of employees.

Very little headway was possible during the year in periodical inspections of field stations, because of the demands made on time and personnel by requests for special investigations and because of the limited number of properly instructed and trained investigators available for this work. Only 14 such inspections were

made. It is believed that with an adequate number of properly trained investigators, well versed in fiscal procedure, regulations, etc., it would be possible to prevent a great many cases of fiscal and other irregularities and to discover others before they became well-established practices. Such a force of investigators would also be of material assistance to field officials in the varied and complicated fiscal operations with which they must deal from day to day.

The work of the year resulted in 964 separate personnel actions, as follows:

Suspension without pay pending investigation	40
Preferment of formal charges	28
Dismissal as a result of formal charges	18
Reprimand by chief of bureau	21
Reprimand by Secretary	8
Reduction in grade and/or salary	13
Reduction in grade and/or salary, and reprimand by Secretary	1
Reduction in grade and/or salary, reprimand by Secretary, and transfer	1
Suspension without pay	20
Suspension without pay and reprimand by Secretary	39
Suspension without pay, reprimand by Secretary, and reduction in grade and/or salary	3
Suspension without pay, reprimand by Secretary, and transfer	2
Suspension without pay, reprimand by Secretary, reduction in grade and/or salary, and transfer	1
Appointment terminated with prejudice	91
Appointment terminated without prejudice	379
Resignation accepted with prejudice	57
Resignation accepted without prejudice	142
Action taken for other than disciplinary reasons	100
Total	964

EMPLOYEE ACTIVITIES

The interest and participation of the personnel in the numerous emplopee activities has continued unabated. The Welfare Association has rendered financial assistance to several activities which were not self-supporting, and also made possible the issuance of a new and attractively illustrated edition of the booklet describing employee activities, which was distributed throughout the Department.

These activities offer to employees opportunities in education, recreation, and amusement, facilitate the extension of acquaintance between different groups of workers, and promote the development of departmental spirit.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - Price 5 cents

REPORT OF THE CHIEF OF THE BUREAU OF PLANT INDUSTRY, 1937

United States Department of Agriculture,
Bureau of Plant Industry,
Washington, D. C., September 14, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I submit herewith a report of the work of the Bureau of Plant Industry for the fiscal year ended June 30, 1937.

Sincerely yours,

Frederick D. Richey, *Chief.*

CONTENTS

The Bureau of Plant Industry has continued its efforts to enable man better to cope with nature in providing himself adequately, efficiently, and certainly with the host of plant products that are necessary to his life and well-being. It is proper that a report should confine itself primarily to completed accomplishments. At the same time, it seems appropriate to mention briefly certain lines of work in which important advances recently have been made promising further accomplishment in years to come.

SOME IMPORTANT ADVANCES BEGUN

During the year, research by the Bureau and cooperating States got under way at the United States Regional Vegetable Breeding Laboratory near Charleston, S. C., at the United States Regional Pasture Research Laboratory, State College, Pa., and at the United States Regional Soybean Industrial Products Laboratory at Urbana, Ill., departmental responsibility for the agronomic phases of which rest with the Bureau of Plant Industry. The physical plant at each of these stations has been practically completed, personnel has been selected and appointed, and plant materials have been assembled, grown, and studied in the initial stages of the respective research programs.

Through the Division of Plant Exploration and Introduction, extensive collections of vegetables from warmer and more humid parts of the world, and which may be expected to have characters of importance in our Southeastern States, have been introduced at the Vegetable Breeding Laboratory. Plant rows and clons of many important species of grasses have been propagated at the Regional Pasture Research Laboratory preparatory to studying the variation in characteristics that may be available for breeding and determin-

ing the combination of these that may be most important in grass and pasture improvement. In connection with the soybean laboratory many varieties were grown in the surrounding States in order to determine the influence of heredity and environment on the characteristics of the soybeans that will make them of value for various technological and other uses.

It is opportune also to mention specifically the progress that has been made toward initiating the general grass-breeding program in areas of the United States other than the Northeast. Nurseries at Pullman, Wash., Corvallis, Oreg., Bozeman, Mont., Logan, Utah, Cheyenne, Wyo., Mandan, N. Dak., Lincoln, Nebr., Manhattan, Kans., Woodward, Okla., Madison, Wis., and Tifton, Ga., afford abundant proof of the promise that grass breeding holds for agricultural betterment. Throughout its history the United States has depended on species of grasses and clovers. Incalculable benefits have been achieved through the introduction by the Bureau of new species from various parts of the world. Until recently, however, there has been little or no effort to isolate from species already at hand varieties superior in one way and another for special uses. What farmer would buy seed oats, seed wheat, or seed corn without reference to variety? Yet this is exactly what he must do at present in the case of grasses and clovers, because as yet there are no selected varieties. It is the importance of the initiation of this undertaking as a milestone in our agricultural research that warrants its mention at this time even though concrete results may not occur for some years.

Specific examples of practical accomplishment during the year are recorded in the following pages of text and in the appended list of some 437 publications emanating from the Bureau through the year.

CEREAL CROPS AND DISEASES

M. A. McCall, *in charge*

Research on cereal crops has continued with the main objectives those of improving quality and overcoming hazards of production, especially by developing superior varieties and by the study of diseases and genetic problems. Attention has also been given to the grain and forage sorghums, to flax, and to methods of controlling weeds.

CORN

Tests in cooperation with the Illinois Agricultural Experiment Station have indicated that the higher levels of fertility obtained by the application of commercial fertilizers together with good farm practices, while they result in higher yields, also result in an increase in diseases in many commercial varieties of corn. Recently hybrids have been discovered that give high yields of sound grain under conditions of high fertility where commercial varieties show excessive injury from stalk and ear rots.

Outstanding yields were obtained from certain of the hybrids in tests in some of the drier sections of the Corn Belt. In Iowa, hybrids outyielded the standard commercial varieties by 30.8 percent, about twice the usual increase. In Illinois the increase was nearly as great. Hybrids developed in cooperation with the Iowa station placed first in five of the eight sectional classes of the State test. Iowa Hybrid 13, winner of the Banner trophy, yielded 26.9 percent more than the average of its class and 79.0 percent more than the average of the open-pollinated varieties. Illinois Hybrid 960, developed in cooperation with the Illinois station, was outstanding in the Illinois tests over a large portion of the State. Both of these hybrids are now in commercial production.

Purdue 14, an inbred line of Golden Rod sweet corn, distributed in cooperation with the Indiana station, has produced excellent hybrids in crosses with Purdue 39 and Purdue 51, the inbred parents of Golden Cross Bantam, previously released. The Purdue 14 × Purdue 15 hybrid has been named Indigold, and the Purdue 39 × Purdue 14 hybrid Purgold.

In cooperation with the Carnegie Institution of Washington, a survey has been made of Guatemala and Mexico for the purpose of locating and collecting seeds of teosinte, a close botanical relative of maize, whose geographic distribution is of importance in determining the region in which maize may have originated. Two new localities for teosinte have been found in Guatemala and two in Mexico. The Mexican localities (northwestern Durango and southern Chihuahua) have a growing season comparable to that of Washington, D. C., and are the farthest north in which teosinte has been found growing wild.

In studies of the effect of light of various wave lengths on the growth of maize seedlings, it has been found that light acts to check the elongation of the mesocotyl, which lifts the germinating seedling to the surface of the soil, and the length of which partly determines the depth of the crown roots. This checking of elongation results from a cessation of cell division. The reduction in cell division is brought about by light falling upon the region at the base of the coleoptile. The coleoptile itself does not appear to be retarded by exposure to light. No wave length of light within the visible range has been found that does not inhibit elongation of the mesocotyl.

WHEAT

As a result of several years' cooperative study at a number of experiment stations about 65 collections of bunt from different sources have been found to include 20 distinct races of economic significance. Crosses of varieties of wheat have been made to combine the resistance to all these races in a single variety. Such a variety has been isolated from the crosses made with winter wheat but not as yet from those with spring wheat.

Continuation of the cooperative grazing experiments with winter wheat at the Fort Hays (Kans.) Branch Experiment Station has shown that the effect of grazing on yield of wheat is determined to a considerable extent by the time of seeding and the variety. Grazing tends to increase winter-killing and reduce tillering or stooling, and as a consequence the most winter-hardy varieties withstand grazing best. Moderately early seeding is desirable for wheat that is to be grazed. If the grazing is timely and not too heavy nor too prolonged, there is little or no damage to the wheat.

OATS

A new red oat (Kansas No. 6138), developed from a Fulghum × Markton cross in cooperation with the Kansas Agricultural Experiment Station, has outyielded Kanota, the standard variety in Kansas, by an average of 9.5 bushels per acre in the last 6 years. It also exceeded Kanota in test weight. This new strain had an average smut infection of less than 1 percent, compared with 25 percent in Kanota. It is now being increased for distribution to Kansas farmers. Alber, an oat variety introduced from South America by the Department a few years ago, appears to be of more promise than any of the new varieties, including Bond and Victoria, that have been tested at the Louisiana station in recent years. It has shown resistance to the physiologic races of crown rust that attack oats in southern Louisiana, and it produces satisfactory yields. High-yielding smut-resistant selections from a Markton × Victory cross are being increased in Idaho and Michigan for later distribution. Satisfactory yields of oats of excellent quality were obtained from many new hybrid selections grown in cooperative experiments at the Iowa station in 1936. The most promising selections were from Victoria × Richland, Markton × Iogold, Iowa 444 × Markton, Bond × Iogold, and Green Russian selection (C. I. 2344) × Bond. Reselections made at the Tennessee station from a Fulghum (winter type) selection (C. I. 2499) sent to that station by the Department have been outstanding in winter resistance at different experiment stations in the South.

BARLEY

Improvement in the malting quality of barley resulted from the application of a nitrogen fertilizer to the soil in experiments in Wisconsin. Malts made from barley stored in the barn previous to threshing were found to be lower in protein and higher in extract and soluble nitrogen in the wort than those from comparable barley left in shocks in the field. The diastatic power of malt varied with the percentage of moisture; malts dried to a low moisture content had a low diastatic power. Experiments with blighted barley showed that it did not malt properly and the kernels absorbed water at a more rapid rate than did healthy grain.

Several years of yield tests of large numbers of selections from numerous barley crosses, under irrigation at Aberdeen, Idaho, showed that in general the high-yielding selections were secured from crosses in which both parents had the same type of spikelet fertility. Most of the best six-row selections came from crosses between two six-row varieties, and the best two-row selections from crosses between two two-row varieties.

The effectiveness of the spore-suspension method of inoculating barley seed with covered smut was verified in the third consecutive year. This method solved a problem of 50 years' standing and has made feasible an attempt to breed barley for resistance to its most important disease.

RICE

In experiments at Biggs, Calif., in 1936 the average increase in acre yield of rice from the application of ammonium sulphate was 1,020 pounds; from ammonium sulphate and potassium sulphate, 1,518 pounds; from ammonium sulphate and superphosphate, 1,638 pounds; and from a complete fertilizer, 1,863 pounds. For several years applications of ammonium sulphate have given marked and consistent increases in yields, but this is the first year that phosphorus and potash applied with ammonium sulphate have materially increased yields. This indicates that, as the land becomes older, it may be necessary to apply phosphorus and probably potash as well as nitrogen in order to maintain high yields.

Experiments to determine the effect of day length on rice, in which plants were covered to exclude light for part of each day, showed that limiting the light exposure to 10 hours daily for a month during midseason caused a shortening of the period between sowing and heading. In some varieties this period was reduced only 2 or 3 days, while other varieties were forced into heading 34 to 69 days earlier than the untreated plants. These experiments show which varieties are most suitable when seeding is necessarily late.

SEED FLAX

In date-of-seeding experiments with seed flax in the Imperial Valley of California, seed sown in September on wilt-free irrigated land failed to produce a stand, although that sown in October or later germinated well and produced a good crop. The temperature of the soil near the surface in that locality during September often exceeds 104° F. in the middle of the day. Laboratory tests showed that the seed does not germinate satisfactorily at constant temperatures of 95° or higher, or when the temperature reaches 104° for a few hours each day. High soil temperatures, therefore, apparently account for the failure to get a stand of flax sown early in the fall in the Imperial Valley.

Experiments to test the value of the treatment of flaxseed with disinfectants before sowing, in order to destroy soil-borne disease organisms, have been carried on at several experiment stations. Three years' tests with formaldehyde, copper carbonate, and ceresan showed that in the Dakotas, Montana, and western Minnesota the yields or stands were not increased or diseases controlled to a significant degree justifying treatment, although in eastern Minnesota the stands were improved somewhat.

SORGHUMS

The severe drought of 1936 greatly reduced the sorghum crop but again demonstrated the ability of sorghums to tolerate considerable drought and heat and to produce much more than did corn under the same conditions. Where drought was very severe, however, no method of culture or of moisture conservation was successful in producing grain. Grasshoppers, which, combined with drought, completely destroyed the corn crop in many localities, caused only limited damage to sorghums. Grasshoppers appeared to prefer milo to other sorghums but usually limited their feeding to partial defoliation. Sooner Milo, an early drought-resistant variety developed by hybridization at the Woodward, Okla., field station, and first distributed in 1930, again demonstrated its value under severe drought conditions in the "dust bowl" region. This variety together with two similar strains later developed in Texas produced most of the sorghum grain that was harvested in drier portions of the "dust bowl" during the last three seasons. Kalo and Early Kalo, two new grain sorghums developed in cooperation with the Kansas Agricultural Experiment Station, are being distributed in western Kansas. Their early maturity, drought resistance, and general adaptation to the northwestern portion of the grain-sorghum region have made these two varieties very popular in western Nebraska, where they were distributed in 1935. Club, a variety of grain sorghum selected from kafir at Hays, Kans., has outyielded all other grain sorghums in most parts of Kansas in cooperative experiments conducted for 5 to 10 years. It is now being distributed to farmers in that State.

The breeding of milo for resistance to chinch-bug injury at Lawton, Okla., has resulted in a large number of hybrid selections that have many of the characteristics of milo but are much more resistant to chinch bugs. Some are early in maturity and short enough for harvesting with a combine. Quadroon, a new grain sorghum developed in cooperation with the Texas station from a backcross of milo on a selection from a kafir-milo hybrid, was distributed to farmers in Texas in 1937. It has many of the characteristics of milo but is more resistant to chinch bugs and has erect heads that are easier to harvest than the recurved heads of ordinary milo.

WEEDS

Studies of methods of controlling bindweed or morning-glory, begun in 1935 in cooperation with experiment stations in eight Western States, indicate that tillage and cropping in combinations suited to the agriculture of the different regions are the most practical way of utilizing large areas of infested land. Winter rye apparently is the crop best able to compete with bindweed. Alfalfa has produced profitable yields despite the bindweed in soils where that crop grows well, provided the vigor of the weed was first reduced by 2 or 3 months of fallow. Soybeans also made a satisfactory growth on infested land in a test in northwestern Iowa. Corn, spring grain, potatoes, and sugar beets appear definitely unsuited for growing on bindweed land. Chemical analysis of bindweed roots has shown that the sugars, starches, and other organic food reserves in the roots are greatly depleted by frequent cultivation and by applications of sodium chlorate. This fact is important in planning cultural and chemical methods of control.

The use of chemical weed killers sometimes has been objectionable because of the injurious effect on crops that follow. In greenhouse studies wide variability was found in the susceptibility of different crop plants to injury by sodium chlorate. Among the most susceptible were sunflower, spinach, beet, chard, rye, and barley. Those showing intermediate susceptibility were soybeans, buckwheat, corn, and rape. Vetch, alfalfa, sweetclover, sorgo, kafir, oats, wheat, millet, and flax were relatively resistant. Temperature influences the toxicity of chlorate in some cases.

COTTON AND OTHER FIBER CROPS AND DISEASES

H. W. Barre, *in charge*

COTTON

REGIONAL VARIETY STUDY

In the regional cotton variety study experiments, which are being conducted for a 3-year period at 14 locations in the main Cotton Belt and 4 locations in the irrigated valleys of the Southwest, more than 60 characteristics under the general classifications of growing conditions, gin data, fiber properties, and spinning utility are under study. The results of the first year indicate that staple length, lint percentage, weight of lint per 100 seeds, and fineness of fiber are inherited and do not change greatly as environment varies. Characteristics such as yield, time required for emergence, time required for the crop to reach the blooming stage, time of opening, and maturity of fiber, on the other hand, are modified to a considerable extent by seasonal conditions at the several locations.

ANTIBIOSIS IN CONTROL OF ROOT ROT

Continued success was obtained from the use of various organic manures applied in deep furrows for controlling root rot under irrigation in Arizona. The same method at Greenville, Tex., during the past year gave promising results for nonirrigated soils. The most important finding was that an unnamed bacterium was particularly abundant in fields where control has been thus effected. When isolated and grown in culture it was able to inhibit the growth of the root rot fungus, *Phymatotrichum omnivorum*, and when an infusion containing these bacteria was poured around diseased plants, most recovered, although neighboring diseased plants not treated continued to die. Even the sclerotia of phymatotrichum, which are ordinarily very resistant and remain viable for several years in the soil, were destroyed. These results

offer an explanation of the effectiveness of organic manures and demonstrate a comparatively new principle in disease control, namely, the use of antibiotic organisms to overcome the disease-causing organisms.

SPACING TESTS

At Greenville, Tex., during 1936—the hottest and driest season on record—it was observed that close spacing of cotton plants favored both production and quality of fiber. A count of prematurely opened bolls made on August 13 showed that the injury was proportionately increased with the thinner spacing of the plants in the row. The percentages of prematurely opened bolls for the several spacings are as follows: Unthinned, 11.2 percent; three plants every 12 inches, 13.3 percent; two plants every 12 inches, 26.0 percent; one plant every 12 inches, 40.0 percent; one plant every 18 inches, 47.0 percent. These differences may be attributable either to earlier fruiting induced by close spacing (the bolls being farther advanced and the hulls tougher and consequently less susceptible to burning injury) or to the greater shading effects of the more abundant foliage having a tendency to protect the green bolls from the direct sun rays.

ACALA BREEDING AND IMPROVEMENT

The breeding by selection of the Acala variety of upland cotton, which the Department brought in from southern Mexico more than a quarter of a century ago, has been continued ever since the arrival of the first stock. Self-fertilization during the last few years in the Acala stocks at Shafter, Calif., is resulting in more uniformity in the strain now designated as Shafter Acala. The self-lining of the Shafter Acala is beginning to show results in further quality improvement in the California crop, and through community organization in the San Joaquin Valley an ample supply of pure seed is provided not only for the cotton-growing areas of California but for other States. College Acala, derived from a somewhat older stock from California, is the basic variety in New Mexico, and one-variety communities provide pure-seed stock for nearly all the cotton-growing area of that State.

Studies of the possibilities of developing a medium-staple cotton having very fine lint, the objective of the Acala-Hopi cross, have been continued. Twenty-four F_2 plants of this cross were selected as representing the best combination of productiveness, large bolls, and longer lint of the Acala parent and the fineness of fiber of the Hopi parent. F_3 progenies of these plants are being grown in 1937.

SEA-ISLAND COTTON

As a result of better yields and good prices for the fiber, the revival of interest in sea-island cotton has continued. In 1936 about 3,500 acres in Florida and Georgia produced 900 bales, which sold at prices ranging from 27 to 33 cents a pound. More than 15,000 acres were planted to sea-island cotton in Georgia and Florida in 1937. In order that the purity of the seed stocks may be preserved for a sustained production of high-quality fiber, the Bureau is cooperating with State agencies in Florida and Georgia in assisting growers to organize into communities growing sea-island cotton exclusively.

Hybrids between sea-island and extra long-staple upland cottons are being produced experimentally in the hope of developing varieties combining the long, silky fiber of sea-island with the greater productiveness, larger bolls, and earlier maturity of upland. In 1936 the F_1 generation from a large number of selected crosses from the preceding year was grown. These hybrids were backcrossed to one or both parents in 1936, laboratory studies were made during the winter, and desirable stocks were sorted out and planted in 1937.

ONE-VARIETY COMMUNITIES

In contrast with a few scattered communities in 1931, about 500 one-variety organizations were in various stages of development in 1936, in 200 counties in 12 States, representing a planted area in excess of 1,000,000 acres. More than half a million bales of even-running lots of community-grown cotton with 1- to $1\frac{1}{16}$-inch staple were produced, and premiums of from $5 to $7.50 a bale were received by the community growers for their improved product. Practically all of the cotton States now have one-variety programs, but

Georgia and Mississippi have made the most notable progress. It is estimated that the extra net profit to participating growers in Georgia during the last 4 years has amounted to $4,500,000. The grade and staple reports show that the percentage of cotton produced in the United States with staple from 1 to $1\frac{3}{32}$ inches has increased since 1932 from 2,693,800 bales, or 21.2 percent of the crop, to 4,302,800 bales, or 35.5 percent of the crop, in 1936. Since the one-variety communities are all based upon proved varieties producing 1- to $1\frac{1}{16}$-inch staple, it is believed that the increase is due in large measure to the community developments and to the general interest they have stimulated in better cotton.

OTHER FIBER CROPS

An 8 years' study on the amount of natural cross-pollination taking place in fiber flax, completed during the fiscal year, shows that the amount of natural crossing in Michigan is approximately three times as great as in Oregon, probably because of a more humid climate in Michigan. The crossing in Oregon, being below 1 percent between adjacent rows, is believed to be so small that nursery improvement work can be carried on there without great space isolation, thus making possible a more economical and simpler breeding program.

Helpful information has aided the hemp industry in assisting farmers who have grown hemp during the past year and new companies in processing their hemp. Recommendations have been made to the Navy Department for specifications for American-grown hemp fiber with a view to improving the market for domestic hemp tow.

DRUG AND RELATED PLANTS

W. W. Stockberger, *in charge*

INSECTICIDE PLANTS

Pyrethrum grown under irrigation at Shafter, Calif., in 1936 gave a calculated yield of dry flowers ranging from 1,275 to 1,650 pounds per acre, being more than twice the yield of 1935. The damaging effect on pyrethrum of ice and extreme cold was demonstrated at La Fayette, Ind., and Huntley, Mont., where most of the plants were lost. The toxicity of the flowers from most localities was lower in 1936 than in 1935, owing perhaps in some cases to difficulty in drying during prolonged wet weather at harvest time.

The mechanical harvesting of pyrethrum was generally satisfactory in 1936 when the plants were not badly lodged. A modified machine has been built combining some features of a corn harvester and a cotton stripper which are expected to adapt it better to heavy and tangled stands.

A report on the first phases of the investigation of *Tephrosia* (*Cracca*) *virginiana*, a native legume, is in course of publication as Technical Bulletin 595. During the year a number of individual plants of apparently greatly superior insecticidal quality were found among several thousand tested, and these are being made the basis for selection and breeding. Some evidence was obtained that toxic plants from Texas when planted elsewhere in a so-called nontoxic area will lose their toxicity in time.

A search for insecticidal plants among the tropical fish poisons was begun in cooperation with the Division of Plant Exploration and Introduction of this Bureau, the Bureau of Entomology and Plant Quarantine, and the Federal experiment station at Mayaguez, Puerto Rico. More than 1,200 powders and extracts representing about 50 genera were prepared and submitted to entomologists for tests on insects. A number of species showed enough effect as stomach poisons to warrant more detailed study, but no contact insecticides of promise were found except the rotenone-containing species.

HOPS

The extent to which the hop crop is affected by downy mildew when conditions favorable to this disease prevail and the importance of studies on its control were demonstrated in 1936, when a severe outbreak resulted in heavy loss in the more humid sections. All of the imported varieties being grown experimentally were badly affected by the mildew. Some of the seedlings from domestic varieties that appeared to have considerable resistance in pre-

vious seasons also were affected, but a few, nevertheless, are considered of sufficient merit to serve as breeding stock. The importance of clean culture and fall removal of dead vines in controlling the disease the following year, which has continuously been emphasized to growers, was well demonstrated.

Studies on hop quality were continued, and 3 years' data were completed on the resin content of the imported varieties grown experimentally in Oregon for disease studies. Some of these are of the same quality as the domestic varieties, and a few are somewhat better, but their yields have generally been disappointing.

DRY-LAND AGRICULTURE

C. E. Leighty, *in charge*

CONSERVING SOIL MOISTURE

In experiments over a period of 20 years at the United States Dry Land Field Station, Mandan, N. Dak., corn has proved more economical than spring wheat in the use of water, and yields of corn have been significantly higher. A greater residue of available water remains in the soil after corn than after wheat harvest. These experiments also have shown that surface condition plays an important part in the conservation or use of soil water. Stubble left on the ground throughout the dormant season is a positive help in checking surface losses. It reduces run-off and surface evaporation and holds snow. Bare ground, whether fallow, fall-plowed, or in corn stubble, stores less water during the fall, winter, and early spring than ground covered with grain stubble.

In these experiments the amount of water saved in fallow, extending from harvest time of spring wheat to seeding time in the spring of the second year following, averaged 20 percent of the precipitation during the fallow period, or 4.48 inches out of a total precipitation of 22.23 inches. More than half of the soil-moisture storage occurred during the period from harvest to seeding time the next spring, while the land was in stubble. In a comparison of plowing for fallow, on June 1 and on July 1, soil moisture stored was 1 inch greater on the early plowed land, and wheat yields averaged 6.6 bushels more.

In cooperative experiments at Hays, Kans., maximum yields of wheat have been produced only when there was a large quantity of water in the subsoil. The roots of winter wheat grown there have been found at times using water from the soil to depths of 8 and 9 feet under extreme drought conditions. On land cropped to winter wheat each year early tillage (immediately after harvest) has shown a marked advantage over late tillage in the storage of water. The early destruction of weeds and loosening of the soil to allow water penetration favors the accumulation of a supply that substantially reduces the risk in wheat farming.

CULTURAL METHODS

In cooperative experiments at North Platte, Nebr., it has been determined that land under cultivation for 44 years (16 years in general farming, mostly to corn, and 28 years in experimental rotation and cultural treatments) has been reduced appreciably in organic-matter content, the reductions ranging from 20 to 42 percent under various practices, in comparison with native sod on adjacent land.

The effect of different spacing of corn plants on the yields of corn and on the yields of the following crops of winter wheat was determined at Akron, Colo., over a 12-year period. The maximum combined yield of ear corn and wheat grain was obtained when the corn plants were spaced 24 inches in rows 44 inches apart. Higher stover yields were obtained from closer spacings. Planting corn in double-width (88-inch) rows reduced the yield of corn in favorable years and did not increase yield or quality in adverse years. Winter wheat following corn grown in favorable years gave higher yields following the double-spaced corn than following corn in regular-width rows, but the increase in wheat yield was much smaller than the decrease in corn yield. Yields of winter wheat following corn grown in adverse years were no higher on double-width than on regularly spaced cornland, indicating that corn is able to remove all the available moisture from the 88-inch space.

FORAGE CROPS AND DISEASES

P. V. CARDON, *in charge*

The regular program of research on forage crops, directed mainly toward improvement of hay and seed quality and increased productivity by developing superior strains and improved cultural practices, was extended during the season of 1936 to include, for the first time, cytogenetic, physiologic, and pathologic studies of grasses in cooperation with Federal and State agencies in the major agricultural areas of the United States.

GRASSES

Extensive nursery plantings of native and introduced species of grasses were made in the Pacific Northwest, the intermountain region, the Great Plains, the Great Lakes region, the Mississippi Valley, the northeastern region, and the southeastern region. Numerous selections were made from important species, and in many instances successful interspecific and intergeneric crosses were accomplished. Preliminary research was undertaken on the cytogenetics of species and the vegetative and reproductive responses of species to different environments. Major objectives in this research relate to (1) increase in production of viable seed of species that normally produce very little; (2) improvement in summer growth habits of important pasture species; (3) greater resistance to drought, winter-killing, disease, and insect injury; (4) greater persistency and longevity of important species that have to compete with other more aggressive species in pasture mixtures; (5) recovery improvement in species now lacking the ability to renew growth quickly after grazing; (6) the development of suitable grazing strains that are tolerant to extreme soil conditions as found on low-lying wet lands or on saline lands; and (7) increased palatability and nutritive value.

A selection of Sudan grass (F. C. 29308) obtained from Texas was outstanding at Beltsville, Md., in tests of vigor and disease resistance.

A green dye that is harmless to grass and yet controls diseases has been developed. It may be used to simulate natural color in grass that has been temporarily discolored by disease or unfavorable weather conditions. This development is particularly important in connection with the maintenance of lawns and golf greens. It is protected by a public patent.

PASTURE IMPROVEMENT

The United States Regional Pasture Research Laboratory, State College, Pa., established in 1935 under a cooperative agreement with the agricultural experiment stations of the 12 Northeastern States, completed its physical plant, consisting of a laboratory building, a head house, and two greenhouses, and selected its personnel preparatory to undertaking a cooperative program of research in pasture improvement. A small grass nursery was planted in the fall of 1936. With the aid of cooperating agronomists in the Northeastern States, seed of bluegrasses, bentgrasses, timothy, white clover, and red clover was collected in old established pastures. These and other seeds collected within and outside of the region were planted in the greenhouses, and the seedlings were later transplanted in the field nursery. These seedlings, individually spaced, included 11,000 plants of Kentucky bluegrass, 10,000 of Canada bluegrass, 10,000 of white clover, 15,000 of Ladino clover, 300 of medium red clover, 300 of orchard grass, 500 of timothy, 1,000 of redtop, 300 of *Agrostis* species, 500 of ryegrasses, 300 of fescues, and 300 of miscellaneous grasses.

Study of the effect of surface applications of lime and fertilizers on soil reaction and available phosphate at different depths was continued on three different soil types in as many different locations in the humid region. The results of 4 years indicate that the effect of surface application of normal amounts of limestone to permanent pastures was confined largely to the 1½-inch surface layer of soil and that penetration was negligible to depths of 3 to 5 inches. After 4 years, 20-percent superphosphate applied on the surface at the rate of 500 pounds per acre per year still remained largely in the 1½-inch surface layer of soil.

21222—37——2

ALFALFA

A definite correlation was found between fall-cutting practices and bud development, winter survival, and yield of alfalfa. Where growth was sufficient at the time of fall cutting to induce storage of ample root reserves the crown buds were larger and more numerous than when growth was less and root reserves smaller. When the first two cuttings were made at the bud stage yields were significantly lower than when cuttings were made at the time the flowers were one-tenth, one-half, or three-fourths in bloom.

A successful method of expediting the increase of seed of improved strains of alfalfa was devised. It entailed the sowing of seed in the winter at Bard, Calif., and the transplanting of seedlings in the spring from Bard to selected isolated fields in Northern States. Forty-six such isolated blocks of seedlings in Nebraska in 1936 produced enough seed for further plantings in 1937 in cooperative nurseries at 40 State agricultural experiment stations. The strains that were increased and distributed by this method are strains highly resistant to bacterial wilt.

CLOVERS

Sweetclover drilled in Sudan grass, sorghums, or grain stubble without loosening the soil resulted in better stands and prevented soil blowing better than when seeded by other methods.

Coumarin or closely related substances in sweetclover are responsible for the toxicity of spoiled sweetclover hay. Annual and biennial forms of *Melilotus dentata* are practically free of coumarin. This fact and the occurrence of wide variations in coumarin content of common white and yellow sweetclover affords a basis of breeding for better strains free of coumarin or with a content so low as not to be injurious.

Resistance to powdery mildew in red clover has been found to be physiological in nature. Rapid disorganization within the cell follows soon after infection by the fungus.

Strawberry clover continued to show a high degree of tolerance to saline soils of the West.

SOYBEANS

In connection with the first year's program of the recently established United States Regional Soybean Industrial Products Laboratory at Urbana, Ill., five standard varieties of soybeans were grown cooperatively on different major soil types in five States (Ohio, Indiana, Illinois, Iowa, and Missouri), and 500 samples of the beans thus produced were sent to the laboratory for analysis to determine the effect of varietal and environmental influences on composition.

Six superior edible varieties of soybeans were distributed for further testing among food concerns, growers, and seedsmen. Six varieties especially suited to forage and commercial seed production purposes were distributed in the Southern States. Thirty newly named varieties suitable for different purposes and for different regions were distributed among State agricultural experiment stations and other cooperators.

MISCELLANEOUS LEGUMES

Lespedeza sericea under conditions prevailing in the Piedmont was more productive than alfalfa on limed and fertilized soil.

Strains of *Crotalaria intermedia* that mature earlier than the original stock were obtained. This indicates that varieties that will produce seed much farther north than at present can be produced.

A general survey was made of the diseases of field peas and vetches in the Cotton Belt, and the extent of damage was noted. Preliminary results indicate that these diseases are not seed-borne but are present locally and increase with continued use of field peas in a given area. Laboratory and field studies of the diseases involved were started.

FOREST PATHOLOGY

HAVEN METCALF, *in charge*

ELM DISEASE RESEARCH

A new method, which is faster than and apparently as effective as the old, has been developed for sampling elm trees suspected of being affected by the Dutch elm disease. Study of the pattern of discoloration found in diseased trees indicated that in most cases suitable samples for diagnosis can be obtained from the trunks as well as from the tops. Samples three-fourths of an inch in diameter are removed at 6-inch intervals from the trunk, examined for discoloration, and, if any is found, cultured to determine whether the Dutch elm disease fungus is present. In certain plots selected for study approximately 50 percent more of diseased trees were found by sampling the trunks than by sampling the tops.

Continued inspection of plots established 3 years ago indicates that removal of diseased, declining, and dead elms from an area will greatly decrease the incidence of disease in the area. Only a few of the trees remaining in such plots after sanitation was completed in 1934 have developed disease. In most cases trees developing disease after sanitation of the plot were found to be root-grafted to stumps of previously diseased trees.

Specimens from approximately 62,000 trees received from 22 States were cultured during the calendar year 1936. Of these 12.5 percent were diagnosed as cases of Dutch elm disease.

WHITE-PINE BLISTER RUST ON SUGAR PINE

As predicted from previous research, white-pine blister rust has appeared on sugar pine in Oregon and California. It took the disease about 15 years to spread to this host from Vancouver, British Columbia, where it was introduced from Europe. Although the disease is still some distance from the optimum range of the valuable sugar pine in California, there is no reason to expect that it will be any less serious on sugar pine than on western white pine, as tests in Oregon show that sugar pine is more susceptible than either eastern or western white pine. Moreover, there are abundant susceptible ribes plants (the alternate host of the blister rust fungus) in the sugar pine forests, and marked damage has occurred on sugar pine in the relatively short time that the rust has been present. At one infection center sugar pines are dying from a multiplicity of branch cankers rather than from trunk girdling, which has been the characteristic method of killing in eastern and western white pines.

In California the white-pine blister rust may soon enter the range of the piñon pine blister rust, a relatively harmless rust from which it must be distinguished on ribes. Hitherto the two rusts have been indistinguishable in the late summer stage on ribes leaves, but during the past year an apparently reliable staining method that differentiates the two rusts in this stage has been perfected.

NURSERY DISEASES

Mainly with funds supplied by Emergency Conservation Work, special attention has been given during the last 2 years to the nursery diseases that have been interfering with the production of planting stock for the emergency tree-planting programs.

It has been found that sour or acid soils are the only kind in which pines and spruces, and in fact most evergreen forest species, can be counted on to stay healthy. On neutral or alkaline soils the so-called damping-off fungi can kill seedlings by the millions and the use of lime is disastrous. Some time ago it was found that sulphuric acid could be applied to ordinary soils to control damping-off. More recently it has been shown by experiments at 10 different localities that still better results can be obtained on many soils by using aluminum sulphate or iron sulphate; these also increase acidity, and the danger of overdosing is less than with the acid.

At many of the Central States nurseries it was found that the sand used to cover the seed contained lime in considerable quantities and was making the soil alkaline or at least defeating the soil treatments. Much damping-off was following its use, and it has now been shown experimentally that alkaline

cover sands increase damping-off in subsequent crops as well as in the crops on which they are applied. At some of these nurseries it was also found that the water supply contains enough alkali salts to decrease soil acidity and increase the amount of damping-off. Measures are being taken to correct these conditions. Alkaline soil also causes chlorosis of conifers. Seedlings become yellow and dwarfed, apparently because of iron deficiency.

CYPRESS CANKER

Cypress canker, which is estimated to have destroyed about 25,000 planted Monterey and Italian cypresses in California, was found for the first time close to the two famous native groves of Monterey cypress on the coast south of Monterey Bay. Discovery and removal of the affected trees before the disease has had an opportunity to become well established in the area is believed to have averted immediate danger to the native groves and to the thousands of valuable planted specimens in the surrounding district. Investigations have demonstrated that, contrary to preliminary laboratory results, deposits of salt from wind-driven sea spray on the native trees cannot be counted on to afford protection against the disease.

WOOD DECAY

An investigation of the changes in strength and chemical composition of red gum sapwood induced by *Polyporus versicolor*, one of the most important hardwood-rotting organisms, has been completed and the results published as Technical Bulletin 527. These data have considerable fundamental significance and find an application in the intelligent selection and use of wood.

Extensive laboratory tests have shown that three of the most common decay organisms that attack forest products will be killed if the temperature at a given point in wood with moisture content above fiber saturation point is maintained for 60 minutes at 150° F., 30 minutes at 170°, 20 minutes at 180°, 10 minutes at 200°, or 5 minutes at 212°. A correlation of these data with information already available on the rate of heat penetration in wood will enable the wood preserver and user to determine schedules for sterilizing wood that has become infected before or after being placed in use.

FRUIT AND VEGETABLE CROPS AND DISEASES

E. C. Auchter, *in charge*

Research has been continued on the breeding, culture, and diseases of fruits, nuts, vegetables, and ornamental plants and their handling, storage, and utilization.

FRUIT PRODUCTION

APPLES

The propagation of apple varieties by cuttings from etiolated stems has been demonstrated to possess considerable practical promise. A technique for etiolating the stems has been developed which consists of placing a black paper tube over the end of a terminal shoot so that the new growth must extend through the tube. This procedure facilitates etiolation as compared with wrapping the stem and adds to the practicability of this method of rooting apple cuttings.

Experiments have been conducted in commercial orchards to determine the effect of manganese, magnesium, zinc, potassium, boron, and complete fertilizers on the development of various physiological disorders of apples. During 1936 it was found that boron applications resulted in commercial control of internal cork in Ben Davis apples in the Shenandoah Valley of Virginia. Applications of zinc sulphate also reduced internal cork, possibly by changing the soil reaction. Complete fertilizers containing appreciable traces of boron also reduced internal cork.

PEARS

Measurement of Anjou pears on both heavy and light soil types has shown that the rate of fruit growth, although following a trend for gradual increase during the summer, fluctuated from day to day. The growth rate was greater following an irrigation and less during hot or windy periods. Such varia-

tions are interpreted to mean that during hot periods Anjou trees lose water from their leaves faster than the water can move into the tree from the soil surrounding the roots, with the result that a water deficit occurs in the tree. As compared with withholding irrigation until nearly all the available soil moisture had been used, irrigating as soon as the average available soil moisture had been depleted to about 50 percent of the available capacity resulted in 30 to 40 percent larger fruit; whereas irrigating when the average soil moisture had been reduced only to 75 percent of the available capacity resulted in from 30 to 60 percent larger fruit. After the first year this increased size was due not only to a reduction in the severity of the water deficits in the trees but also to increased leaf area per fruit.

GRAPES

Until recently the testing of grape rootstocks in vinifera regions has related mainly to stocks that were resistant to phylloxera and the determination of congeniality of varieties and adaptability to different soil and other conditions. In recent years resistance to nematodes has been of increasing importance because of the spread of the nema and its destructiveness in many vineyards. During the past year, as a culmination of previous years' investigations, some rootstocks were found to be highly resistant to nematodes besides meeting all other essential requirements of a desirable rootstock.

CRANBERRIES

Among the various fungicides used to combat cranberry rots, bordeaux mixture with soap proved to be the most effective. In Massachusetts a 5–2–50 bordeaux mixture gave better control than when a smaller proportion of copper was used. Better control of rots and a higher yield were obtained in 1936 on plots that were sprayed with bordeaux mixture in 1935 than on plots not sprayed that year. The spray resulted in other beneficial effects, indicating a probable deficiency of copper in the bog soil.

In New Jersey, applying dust fungicides with airplanes was fairly satisfactory where the vines were not thick, but ground dusters gave better control under all conditions. A comparison of liquid and dust fungicides showed a decided advantage in favor of the liquid.

DATES

Several lots of date pollen were collected in 1935, placed in vials, sealed, and stored at 8° F. Other lots were treated the same except that they were not held in cold storage. In 1936 the pollen held in cold storage gave sets of fruit comparable to those from fresh pollen; the pollen not cold-stored gave no set. These results indicate that at low temperatures it may be commercially practicable to hold over date pollen for breeding purposes from one year to the next.

NUTS

PECANS

In the planting of pecan orchards in Georgia, as in many other sections, the trees in many orchards were placed too close together, resulting in crowding as they attained age and size. Experiments on remedying this condition have been in progress for some time. Reducing the stand 5 years ago has resulted in the greatest tree growth and next to the largest average annual acre yields and size and degree of filling of the nuts. Heavily pruned trees have produced the largest and best-filled nuts of any, but the yields and tree growth have been so poor as to make this treatment the least profitable. The trees receiving heavy applications of a nitrogenous fertilizer have produced the largest average annual yields per acre, but the increase in yield has just about paid for the increased fertilizer. These latter trees have developed a strong biennial bearing tendency, and severe rosette is appearing.

During the harvest season of 1936 in Arizona it was definitely determined that ethylene is effective in loosening the shucks of pecan nuts. The evidence indicates that in this region of high fall temperatures normal shuck opening may be delayed beyond the period of maturity of the kernel. By picking the nuts when maximum kernel quality has been attained and loosening the shucks

through the use of ethylene it becomes possible to avoid most of the loss from preharvest germination and at the same time to place the nuts on the market earlier.

Commercial control of the pecan scab fungus on the Schley variety in Georgia was obtained by making four applications of low-lime bordeaux mixture to the trees. The estimated gain of the sprayed plots over the unsprayed checks amounted to $8.25 per tree, or $82.50 per acre. Experiments in Louisiana have given helpful results in the control of downy spot and vein spot by the use of bordeaux mixture and oil in certain modifications and combinations.

ALMONDS

Two promising hybrid selections from the almond-breeding work in California mentioned in last year's report are being widely tested in commercial almond areas with a view to determining their commercial merit and their adaptability. Other new hybrids from which nuts were harvested and evaluated in 1936 seem to have commercial possibilities or to possess characters that make them of value in future breeding work. Two of them, besides producing nuts of superior commercial value, are also resistant to the so-called red spider.

In tests to determine whether or not pollen of the bitter almond applied to the stigmas of sweet almond varieties affects the resulting kernels in flavor, no bitterness in flavor was added to the kernels of the varieties pollinated.

PERSIAN WALNUTS

Experiments supplementing previous work show that under orchard conditions the pollen of the Persian (English) walnut is not distributed by the wind over the very long distances hitherto believed, but that from a commercial viewpoint the pollen is commonly carried in the direction of the wind over several rows. This fact is important in determining the location and number of trees interplanted for pollination purposes. The probability of stigmas receiving pollen at various distances has been calculated.

VEGETABLE PRODUCTION AND DISEASES

TOMATOES

Studies on the causes of pocketing, embryo abortion, and other related responses of the tomato have shown these phenomena to be expressions of various adverse growth conditions. Tomato pocketing was most pronounced on plants grown in a greenhouse maintained at a temperature of 60° to 65° F., less so at 75° to 80°, and still less at 70°. Degree of seedlessness and accompanying pocketing agrees with certain known effects of adverse temperature or nutritional conditions, saturation or supersaturation of the soil, and excessive drought.

A fairly homozygous, medium-sized, smooth, firm, late shipping and canning tomato, resistant to fusarium as well as to verticillium wilt, has been developed. It is an eighth generation of the cross Cal–2 × Marvana. It is named Riverside and is best adapted to a warm and long growing season. Seed has been distributed to seedsmen in sections suitable for the propagation of the new variety.

CUCUMBERS

Field trials for resistance to bacterial wilt of cucumbers, conducted in the East in 1936, showed definite evidence of wilt resistance in hybrids, several of which also showed outstanding resistance in the trials of 1934 and 1935. All these hybrids are of mosaic-resistant parents crossed with commercial varieties. Hybrids with pickling varieties as one parent generally show more resistance than hybrids with slicing varieties. Tokyo Long Green appears most resistant to wilt of any of the mosaic-resistant varieties. Two commercial varieties (Cool and Crisp and National Association Pickle) possess marked wilt resistance.

SWEETPOTATOES FOR STARCH

Thirty-one selections and little-known varieties of sweetpotato were tested in individual plots for their value for starch manufacture in the Gulf States. Triumph is at present the outstanding starch-producing variety. Of the newer selections, there are indications that Wennop, which held third place in total

yield among those grown at Meridian, Miss., in 1936, not only gives a high total yield but has a high yield of starch of exceptional quality which apparently requires less bleaching than does starch from other varieties.

DISEASE-RESISTANT MUSKMELONS

Powdery mildew-resistant cantaloup No. 45, mentioned in last year's report, came fully up to promise on the 10,000 acres grown in the Imperial Valley of California in 1936. The vines were entirely free from mildew, and the melons were not only of high quality but showed outstanding adaptation to long-distance shipment, reaching markets in all parts of the country in a condition very satisfactory to both dealers and consumers. As a result most of the 1937 cantaloup acreage in the Imperial Valley and in Arizona, which sections produce most of the early cantaloups of the country, was planted to No. 45.

Powdery mildew-resistant Honey Dew No. 60, introduced in 1934, is proving under commercial production to be inferior in certain respects to the standard Honey Dew variety. Progress is being made in overcoming these faults by backcrossing with Honey Dew and selecting further.

PEANUTS

Selection of peanuts for larger-sized nuts, begun in cooperation with the Virginia Agricultural Experiment Station, has so far resulted in six strains all having inherently large seeds combined with high yield. Seed has been placed in the hands of selected growers who have agreed to make the increase available for seed purposes.

HANDLING, TRANSPORTATION, AND STORAGE OF FRUITS AND VEGETABLES

NEW TYPE PACKAGE FOR PEACHES

Studies at Fort Valley, Ga., and Bonsack, Va., have resulted in developing a ventilated package that permits the rapid cooling of all the peaches when precooled in a loaded refrigerator car. In the tight, unventilated baskets previously used the peaches receive but little benefit from the precooling process, as the drop in temperature is largely confined to those in contact with the sides of the basket. The new package consists of a basket with spaced staves, a crown cover, a slotted liner, and a ring pad which facilitates circulation of air throughout the package. It gives quicker cooling during the precooling process and also lower temperatures in transit, and it should permit the shipment of more mature peaches of better eating quality.

TRANSPORTATION OF CITRUS FRUIT

In test shipments of citrus fruits from California and Arizona it was shown that precooling of the fruit to a temperature of 34° to 36° F. effectively supplements refrigeration from the ice in the bunkers of the car. Precooling to a relatively low temperature resulted in less meltage of ice during the initial part of the trip and appears to be an effective aid in the refrigeration of oranges under half-bunker icing. Better air circulation was obtained with ice in the upper half as compared with the lower half of the bunkers, thus reducing the spread of temperature between top and bottom layers of the load. The results of half-bunker and full-bunker icing experiments indicated that the ice in the lower half of the bunkers is relatively ineffective. In tests in transit during cool weather and during high summer temperatures, upper-half-bunker icing provided about the same refrigeration of precooled oranges as full-bunker icing and avoided the haulage of surplus ice. The method appears to be suitable for use on shipments of precooled oranges and lemons amounting to over 30,000 cars a year.

STORAGE OF CITRUS FRUIT AFTER SHIPMENT

The best storage temperature for Florida- and California-grown Valencia and California-grown Washington Navel oranges was found to be 32° F., although brown stain and watery break-down developed in several lots held at that temperature. Pitting was generally worst at 36° and 40°, wilting worst at 40° and above, and decay worst at 45° and 50°.

The best storage temperatures for the prevention of pitting in Florida grapefruit were 45° and 50°; however, loss from decay was most serious at these temperatures. At lower temperatures, although decay control was correspondingly improved, pitting was serious after 1 month's storage. Temperatures of 32° and 36° caused much more pitting damage to grapefruit than to oranges.

In all lots of oranges and grapefruit the fruit was firmer and better flavored and had more green buttons at lower temperatures and was more highly colored at higher ones. Loss from decay increased directly with raising of storage temperature. In most of the lots acidity was higher at the lower temperature.

PRECOOLING AND TRANSPORTATION OF GRAPES

A series of 38 precooling tests with California grapes indicated that better results could be obtained by giving particular attention to the ice melted rather than to temperatures taken in a few lugs of the load. For every 1,000 pounds of ice melted with inside fan equipment a carload of grapes is cooled about 3° to 3.5° F., and with most fan equipment top layers are cooled the most.

Grapes cooled to less than 50° F. throughout the car were shipped in late September to eastern markets in good condition with one reicing in transit. When precooled below 48° and shipped with only initial block ice no reicing was necessary.

Tests under a wide range of transit temperatures and methods of shipping revealed little differences on arrival that could be attributed to precooling or method of shipping. The chief value of precooling grapes is apparently in saving icing charges in transit.

HARVESTING AND TRANSPORTATION OF CANTALOUPS

Hale Best melons picked at the half-slip, at the full-slip hard-ripe (green background), and at the full-slip field-ripe (yellow background) stages of maturity were stored at various temperatures from 40° to 90° F. Those from 40° to 50° were transferred to 70° to ripen after 3 and 6 days, to duplicate the handling of shipments under refrigeration during transit to market. In general melons picked at the hard-ripe stage attained the best flavor, and this proved to be the most satisfactory stage for shipping. The half-slip melons when ripened under the most favorable conditions attained almost as good flavor, but the color never developed as attractively. As a rule field-ripe melons that had reached a yellow color did not attain as good flavor as those picked when full-slip and hard-ripe. Few melons ripened to a good flavor at 80° or 90°, there being a tendency for them to soften but not to ripen to good flavor.

The only external characters found to be indicative of dessert quality of cantaloups were amount of slip, color, and firmness. Kind of netting, amount of aroma, specific gravity, and other indexes were found to be of little value. The new powdery mildew-resistant cantaloup No. 45 was of the best quality on the market when picked at the hard-ripe stage. The "choice maturity" stage was attractive, but the flavor was not so good as that of the hard-ripe or fancy melons. Hard-ripe melons thoroughly precooled were transported to the New York market in good condition and remained so for 3 days after unloading. Precooling to be effective must lower the temperature of melons in the center of crates throughout the car to about 50° F. or less.

MYCOLOGY AND DISEASE SURVEY

H. A. Edson, *in charge*

INVESTIGATIONS, IDENTIFICATION, AND COLLECTION OF FUNGI

The mycological collections of the Bureau with associated units now total 376,493 specimens. Over 6,000 were added during the year, including not only material from the usual American sources, but important series from Europe, China, Central America, and other parts of the world, all of value for comparative purposes. About 2,300 exchange specimens of fungi were sent to other institutions, domestic and foreign.

The scheduled appearance of the 17-year locust in the late spring of 1936 gave an opportunity for studies of the life history of the rare fungus parasite

(*Massospora cicadina*) of this insect. Similar studies on fungi attacking the corn earworm, the clover leaf weevil, and other economic insects have indicated the methods by which such fungi are transmitted and have developed other important details in their behavior.

PLANT DISEASE SURVEY

The collaborators and contributors of the Plant Disease Survey have shown much interest in this project, and more than the usual number of items on the incidence of plant diseases have been contributed. The information so collected is distributed to interested institutions and persons through the Plant Disease Reporter, a mimeographed publication.

MUSHROOM INVESTIGATIONS

As a result of studies on the high-temperature fermentation of manure, a new process of growing mushrooms has been developed which combines the advantages of the high yields obtained in special houses with the low cost of operation incident to the year-round production of mushrooms in caves or abandoned mines. The process, for which a public service patent has been granted, consists in fumigating and fermenting the manure under controlled conditions and then transporting it into the cave or mine for use in growing mushrooms.

NEMATOLOGY

G. STEINER, *in charge*

CHEMICAL CONTROL OF PLANT-PARASITIC NEMATODES

Because of the difficulty of finding means of destroying nematode pests of plants in the parasitic phase without at the same time damaging the plant host, efforts for chemical control of these pests are confined to preparations and methods of application effective against the free-living or soil phase only. Few chemicals have been found to be of any value for this purpose, and none are as yet satisfactory. Field tests with a variety of preparations have shown the following to be the most effective: Chlorpicrin applied at 200 pounds to the acre (cost in 1936 about $220), carbon bisulphide at 1,000 pounds per acre (cost about $100), and carbon bisulphide emulsion at the rate of 1 gallon to 100 square feet (cost about $300). Chlorpicrin being a war gas and carbon bisulphide being inflammable, their application requires caution.

SEED-INFESTING NEMATODES

Very little was known until recently of the occurrence in this country of nematode species belonging to the group of plant-parasitic forms, of which the wheat nematode is a member, which frequently infest seeds, particularly of the grass family. An outbreak of one of these species was observed on bentgrass in Oregon. Two new species were also found, one forming inflorescence and bud galls on buffalo grass in Oklahoma and Texas, and another on a wild sugarcane species introduced from Turkistan. Control of these forms by cultural practice is thought possible. Buffalo grass seeds are known to have a very low germination, and it is possibly of significance that normally these seeds are heavy carriers of numerous free-living nematodes.

BUD AND LEAF NEMATODE

Study of the bud and leaf nematode, especially as affecting strawberries, has been continued. Rearing of the southern strawberry strain for 9½ months on culture media (the nema feeding on fungi) does not change its pathogenicity for the strawberry plant. A test of the development and behavior of different strains of this nema under identical environmental conditions resulted in differentiating the southern and northern strawberry strains, the trollius strain, the begonia strain, and the fern strain, but not the chrysanthemum strain. From 3 years' experiments it appears that the southern (Willard, N. C.) strawberry strain causing "summer dwarf" is unable to establish itself in Wareham, Mass., but the northern (Cape Cod) strain, causing "spring dwarf", does so in the South (Willard, N. C.).

PLANT EXPLORATION AND INTRODUCTION

B. Y. Morrison, *in charge*

PLANT INTRODUCTION

New and valuable economic and ornamental plants that give promise of usefulness in the agriculture and horticulture of the United States are procured from foreign and domestic sources by exploration, purchase, and exchange. Efforts are directed into particular fields to meet the needs of special projects of the Bureau and of other branches of the Government service. The plant material is carried through the necessary stages of quarantine and propagation in the various introduction gardens of the Bureau before it is distributed to research workers.

During the year the introductions totaled 7,659—an unusually large number. Among them were 2,985 for the vegetable-breeding project including the United States Regional Vegetable Breeding Laboratory near Charleston, S. C., 933 introductions of grasses and other forage plants, 604 of fruits, and 411 of tobaccos. Material released and distributed to research workers and collaborators for testing, in the form of plants, seeds, bud sticks, cuttings, roots, and tubers, amounted to 106,764 items, of which 95,661 went to cooperators in this country and 11,103 to foreign cooperators and governments.

BOTANICAL INVESTIGATIONS

In addition to their regular research work, botanists in the Division identify plants for many other services. During the fiscal year 8,793 specimens were identified, of which nearly half were for the Forest Service and the remainder for the Bureau of Plant Industry, the Soil Conservation Service, the Bureau of Entomology and Plant Quarantine, the National Park Service, the Office of Indian Affairs, and miscellaneous correspondents.

RUBBER-BEARING PLANTS

In the continued study of native plants of possible value in rubber production, rubber has been found in the leaves of the evening primrose, *Oenothera biennis*, and related species. Individual plants have been tested with as much as 6 percent of rubber in the leaves, and relatively high-yielding strains have been identified.

Over 100 Hevea rubber trees are fruiting in Florida this year. Owing to the light winter of 1936–37, several trees carried their fall seed crop through, and the rest set their crop in the spring. Regular crops of seed may now be expected.

SEED INVESTIGATIONS

E. Brown, *in charge*

SEED GERMINATION AND TESTING

Work has been continued on determining the fundamental germination requirements of seeds, to obtain a more reliable basis for methods of testing, and also on the effect of different conditions of storage on the longevity of various crop seeds. Results of both lines of research with regard to fescue seed have been prepared for publication. Similar studies on the germination requirements of seeds of certain weeds and native western range plants and on the storage of soybean seed are in progress.

The demand for information on the germination of seed samples has increased, especially from the various purchasing divisions of the Government and in connection with cooperative research work of the Department of Agriculture. More than 500 germination tests were made in connection with the cooperative wheat-storage project. There has also been a greater demand for germination tests on seeds of trees and shrubs and new forage plants. During the year a total of 22,677 samples were examined in the central laboratory at Washington and in the laboratories maintained in cooperation with the States of Indiana, Missouri, California, and Oregon.

ENFORCEMENT OF THE FEDERAL SEED ACT

An important feature of the year's work was the examination for origin, testing, designation of color to be used in staining, and supervision of staining of over 16,000,000 pounds of imported red clover and alfalfa seed. This large volume of importation was due to the shortage of domestic seed of these two important forage crops. Importations subject to the Federal Seed Act are sampled by the Customs Service, the samples are tested for quality by the Division of Seed Investigations, and the collectors of customs are informed of the results. During the year 2,835 lots (43,929,100 pounds) were permitted entry, 149 lots (1,278,300 pounds) were rejected, and 1,180 lots (7,872,500 pounds) were examined and found to be not subject to the act.

SOIL FERTILITY INVESTIGATIONS

OSWALD SCHREINER, *in charge*

PECAN SOIL FERTILITY

During the year a soil correlation study of the southeastern pecan belt was completed and a map prepared showing the location of the soil groups best adaptable to pecan production, together with descriptions of the specific soil types. Soil-reaction studies definitely show that pecan soils fertilized with acid-forming nitrogen may become sufficiently acid to prevent the successful growth of legume cover crops essential in successful pecan growing. However, acid-forming nitrogen can be profitably used in pecan soil fertilizers when made nonacid-forming with limestone. Best results on pecan tree growth and yield were secured when nitrogen was used in conjunction with phosphoric acid and potash.

FERTILIZER STUDIES WITH COTTON

A report was issued as Bulletin 196 of the Georgia Agricultural Experiment Station giving the results of 8 years of cooperative soil-fertility experiments on five soil types, showing that largest returns from cotton fertilizers were obtained when 32 pounds each of phosphoric acid, nitrogen, and potash per acre were supplied. Of the total increase 76 percent was due to nitrogen, 8 percent to phosphoric acid, and 16 percent to potash. A second report, giving the results of studies of means of adapting high-analysis fertilizers to cotton soils, shows that such fertilizers properly formulated can be used in cotton growing and materially lower the cost of production. In fertilizer-placement studies with cotton it was found that side placement, which has given best results, can be accomplished with comparatively inexpensive equipment.

SOME NEWLY ISOLATED SOIL CONSTITUENTS

The studies of organic chemical constituents of soils have been directed toward identification of the organic compounds present in the water extracts, because of the significance of the soil solution in plant nutrition. Two organic compounds, not hitherto recorded as occurring in soils, have been isolated from extracts made by simply percolating the soil with warm water. One of these, allantoin, related to uric acid and urea, and rather easily converted to the latter, has been identified in the aqueous extract of four soils of quite different physical characteristics and from widely separated locations. This compound is of probable significance in the nitrogen nutrition of plants. A second compound, dicarboxylic glutaric acid, has been separated from extracts of a Florida marl soil, in which it occurs as the readily soluble calcium salt.

SOIL MICROBIOLOGY

CHARLES THOM, *in charge*

SOIL INOCULANTS

Legume nodule organisms are commonly applied to seed as a water suspension, but this necessitates care in subsequent handling. Dust or dry carriers have been proposed. In field experiments during 1936 wet inoculation gave two to three times as much forage, carrying 100 to 150 pounds more

nitrogen to the acre, as did comparable dry inoculation. Search for convenient forms of inoculation will continue, but the dry inoculants have not thus far proved satisfactory.

INOCULATION TO COMBAT ROOT DISEASES

The root systems of plants in special plots of cotton in Texas were inoculated with selected molds and bacteria, and after periods of 1 and 2 months the plants were examined to determine whether such inoculation can be used on a field basis to establish a desired species in a particular area. While not uniformly successful, recovery of the test organism from the root systems was sufficiently common to justify the following up of the idea as one possible line of control in combating root diseases of crop plants.

AEROBIC SPORE-FORMERS

From a comparative study of cultures from type collections, private collections, and medical laboratories, it is concluded that the most common spore-forming bacillus of the soil, *Bacillus cereus*, has been isolated repeatedly in medical laboratories, where it has been called *B. siamensis* and perhaps half a dozen other names. The assumption that *B. cereus* is strictly a soil saprophyte breaks down. The old line between the parasitic and saphrophytic species grows indistinct under such investigation. Enough has been done to emphasize the need for many similar comparative studies.

SUGAR PLANT INVESTIGATIONS

E. W. Brandes, *in charge*

SUGARCANE

Further progress has been made in breeding sugarcane to combine high yield, disease resistance, and earliness. A new variety, C. P. 29/116, was released for commercial culture by the Bureau of Plant Industry, the Louisiana Agricultural Experiment Station, and the American Sugar Cane League in the fall of 1936. This variety, developed by the Bureau at the Sugar Plant Field Station, Canal Point, Fla., has been tested for both sugar and sirup production at four stations in the Gulf States in 3 previous years, and results indicate that it is about the equivalent of one of the varieties most widely planted at present but is definitely more resistant to mosaic. Approximately 600 tons of seed cane were distributed to farmers.

In the breeding work more than 50,000 sugarcane seedlings were produced in 1936, together with 1,000 intergeneric hybrids of sugarcane × sorghum, the latter representing attempts to develop earliness in maturity. For the first time seedlings were produced by backcrossing sugarcane-sorghum hybrids with sugarcane. The seedlings survived only a little over a month, but the work proves that this backcross may be accomplished.

Definite progress has been made toward incorporating the rather elusive windrowing quality essential for replacement of Co. 281, which has heretofore served as the chief variety for windrowing and prolongation of grinding after late December and January freezes. Co. 281 is damaged by root rot and has shown increasing percentages of mosaic. Two promising seedlings have been selected from a lot of 200 tested. Related work on cold tolerance included tests of the wild cane *Saccharum spontaneun* from Turkistan, mentioned in last year's report. This plant survived temperatures as low as 15° F. at the Arlington Experiment Farm (Virginia) during the winter of 1936–37. Efforts are being made to cross it with cultivated varieties.

Five new strains of sugarcane mosaic were discovered during the year, making a total of nine recognizable strains of this disease. In cooperation with the Bureau of Entomology and Plant Quarantine, a new insect vector of mosaic, *Toxoptera gramium*, was discovered.

SUGAR BEETS

CURLY TOP-RESISTANT VARIETIES

Success has attended the use of curly top-resistant varieties of sugar beet in the western United States. Approximately 150,000 of the 280,000 acres in the curly top area were planted with these varieties in 1936. In the inter-

mountain region U. S. 33, U. S. 34, and A. S. C. 600 are used almost exclusively, and in California U. S. 33 is used very largely in spring plantings. With the greater curly top control that has resulted from the new varieties, the industry is returning to areas previously abandoned, notably the Yakima Valley of Washington and the San Joaquin Valley of California. U. S. 12, a variety having greater curly top resistance than previous releases, has been made available in quantity to plant 1,000 acres for seed production.

VIRUS STUDIES

A disease of sugar beets, savoy, occurring generally in eastern areas, and simulating curly top in its general appearance and effects, has been found to be of virus nature. The vector is *Piesma cinerea*, a common insect on species of *Amaranthus*. In certain sections of Europe a somewhat similar virus disease, transmitted by another species of *Piesma*, causes damage comparable to that of curly top. Savoy, although reported as serious from 1890 to 1900, has been of minor importance in recent decades in the eastern United States.

LEAF SPOT-RESISTANT VARIETIES

Leaf spot of sugar beets under epidemic conditions may lower the yield of roots as much as 50 percent. Certain F_1 hybrids produced from leaf spot resistant inbred lines have shown superior yields while maintaining resistance and high quality, forecasting their success as replacements for present varieties not leaf spot resistant. A synthetic variety, produced by intercrossing resistant inbred lines, designated as U. S. 217, when tested in five States in 1936 gave a yield of roots practically equal to that of European brands with which it was compared, was significantly higher in sucrose percentage, and produced approximately 200 pounds more sugar per acre. Seed of this variety is being provided for planting commercial acreage.

SUGAR-BEET SEED

Seed production as a commercial enterprise directed to bring improved varieties of sugar beets into use by American farmers has grown out of the pioneer investigations of the Bureau. By steady output of new improved varieties the results of disease-resistance breeding investigations have been brought into prompt use. In 1936, 5,250 acres in five States produced approximately 7,800,000 pounds of seed, of which 5,358,000 pounds were from varieties released by the Bureau. Problems in production of seed from varieties with reduced bolting tendency have been partly met by results of seed vernalization tests, early planting tests, and environmental control.

TOBACCO AND PLANT NUTRITION

W. W. Garner, *in charge*

HEAVY POTASH FERTILIZATION TO IMPROVE TOBACCO QUALITY

It is generally recognized that cigar types of tobacco must be provided with a liberal supply of both nitrogen and potassium, and on light soils as much as 200 pounds per acre of each is commonly applied as fertilizer. The ratio between the nitrogen and potassium in the fertilizer approximates unity. With cigarette tobaccos, especially the Maryland and flue-cured types as grown on light soils, it has long been considered that to obtain the highest quality product only about 25 to 30 pounds of nitrogen per acre can be safely used, and the quantity of potassium has been about the same or only slightly greater. As a result, only relatively low yields have been commonly obtained, and as a rule free use of legumes for soil improvement has been precluded. For a long time, experiments in the use of additional quantities of potassium failed to give striking results, apparently because the increased applications were much too small. In recent years marked improvement in quality combined with good yields has been consistently attained by establishing a wide ratio between the potassium and nitrogen in the fertilizer. The rate of potash fertilization is made to approach that employed for cigar tobaccos, but with only a moderate increase in the nitrogen supplied. This appears to be largely the key to increasing the acre output of high quality cigarette leaf and is believed to be one of the important advances of recent years in tobacco fertilization.

BREEDING TOBACCO HYBRIDS FOR HIGH NICOTINE

Strains of *Nicotiana rustica* var. *brasilia* that contain a high percentage of nicotine have been selected for prospective use in the manufacture of insecticide. This variety, however, like most other forms of *N. rustica*, produces a rather low tonnage of dry matter. *N. tabacum*, on the other hand, produces a high yield but is rather low in nicotine content. Crosses between the two species have been made with the object of combining the favorable characteristics of each. Among the hybrids so far produced are some very large plants with pronounced rustica characteristics and some high-nicotine segregates with comparatively suckerless growth habit.

CONTROL OF TOBACCO SEEDBED DISEASES

One of the most pressing needs of the tobacco grower is for more effective methods of disease control in the plant beds.

In the year under review control of blue mold has again been secured by both heat and gas treatments. The gas treatment (originated in Australia) appears particularly promising provided growers will construct beds suitable for its use. However, special attention has been given to the development of a spray treatment with a view to making it possible for growers, without changing present seedbed methods, to control blue mold and also to eliminate wildfire and blackfire from their beds. During the last 2 years a combined bordeaux and copper oxide-oil spray schedule has effectively controlled blue mold and eliminated wildfire from beds in Maryland. Last spring in Georgia the copper oxide-oil alone gave adequate blue mold control under very severe disease conditions. While these studies are not complete, they indicate that it will be possible for growers to insure an adequate supply of healthy plants at the proper time.

WEEDS IN RELATION TO GRANVILLE WILT

The fact that many weeds are susceptible to Granville wilt and aid in maintaining the infestation in soil in the interval between tobacco crops has long been known. To control the disease it has been recommended that growers rotate tobacco with immune crops such as corn, but many have failed to secure control by rotation. In 1936 a study was made at Creedmoor, N. C., of weed populations in fields that were to be cropped to tobacco in 1937. Of 103 species of weeds found, only 8 are known to be susceptible to wilt, and only 8 percent of the fields studied were free of wilt-susceptible weeds. The small number of species of wild host plants found growing in cultivated fields suggests that it would be simple for growers to familarize themselves with these and by a small amount of work greatly increase the value of their rotations.

CHEMICAL ELEMENTS IN PLANT NUTRITION

A study with *Aspergillus niger* of each mineral constituent of the nutrient solution has revealed that molybdenum bears a special relation to the nitrogen metabolism of plants. The quantity of molybdenum required varies with the form of nitrogen supplied and is greatest with nitrate nitrogen. With ammonia nitrogen omission of molybdenum results in a 20-percent decrease in yield, whereas with nitrate nitrogen the decrease is 90 percent. Only about 1 part of molybdenum per 50 million parts of nutrient solution is necessary. Molybdenum seems essential for activation of the nitrate reducase of the plant in the processes whereby ammonia is formed for synthesis of amino acid and protein. It was demonstrated also that ammonia, nitrate, and certain forms of organic nitrogen are exactly equivalent for nutrition, if the other constituents are present in suitable concentration.

WESTERN IRRIGATION AGRICULTURE

C. S. Scofield, *in charge*

In recent months extensive data have been assembled concerning the quality of irrigation and underground waters in the Rio Grande Basin above Fort Quitman, Tex., extending through New Mexico to southern Colorado. These data are a contribution to a more general report of the hydrology and agriculture of this basin, made by the Rio Grande joint investigation under the direction of the National Resources Committee.

SAND-CULTURE EQUIPMENT AND PLANT NUTRITION

Water and sand cultures provide physiologists with a valuable tool in the study of the nutritional requirements of plants. An automatically-operated sand-culture equipment has been developed as an adjunct to studies of the effects of boron and other salt constituents of irrigation waters on crop plants. The equipment promises to be of general value to physiologists whose nutritional problems are of a quantitative character. The sand cultures, either in the form of metal benches or as concrete beds, are supplied with nutrient solutions by clock-controlled motor pumps. The beds, which are free-draining, are flooded with nutrient solutions at hourly or other elected intervals, from reservoirs of large capacity. The residual solution from the previous application is displaced by the new solution and returns to the supply reservoir by gravity.

In conjunction with the studies of sand-culture methods it has been found that plants may obtain ample supplies of iron from relatively insoluble minerals such as magnetite, the black ferrous-ferric oxide of iron. Corn plants, which have relatively high iron requirements, needed no additional supply of iron when grown at pH values as high as 9 in washed sand from the California ocean beach. Pyrites was likewise found to be a suitable source of iron at pH values above neutrality, but injury, possibly due to selenium, sometimes resulted when this mineral was used in slightly acid solutions. The conclusion is indicated that iron derived from these slightly soluble minerals is absorbed directly across the root-particle interface without being dissolved into the nutrient solutions.

LAND RECLAMATION

The land-reclamation investigations have contributed to developing practical methods of removing the salts from highly saline soils and developing a better understanding of some of the fundamental factors in the sustained productivity of irrigated lands. It has been found that the extent of crop injury from subsoil saturation is closely correlated with the salinity of the subsoil water. Investigations have shown that the chief cause of waterlogging in irrigated soils comes from percolation of water from irrigation ditches rather than from the irrigation water applied to the land. Where excessive salinity contamination exists chemical treatments have proved to be too costly for general application. Practical and satisfactory methods have been developed by adding organic matter to such soils, either in the form of farm manure or by growing such crops as sweetclover, and the adoption of improved irrigation practices.

PUBLICATIONS, INFORMATION, EXTENSION

During the year, 101 publications (80 new and 21 revised) contributed by the Bureau were issued in the Department series. These comprised 40 papers in the Journal of Agricultural Research, 17 technical bulletins, and 44 other items, semitechnical or popular. In addition, there appeared in outside scientific agricultural, and commercial publications 390 articles written by members of the Bureau's staff on various subjects related to its field of activity. A list showing the new official publications and most of the outside contributions is appended.

The Bureau provided a large portion of the material for the Department's Yearbook of Agriculture for 1937. Its contributions consisted of 33 papers dealing with the genetics and improved breeding of vegetables, fruits, nuts, forage crops, etc.

The Bureau continued to cooperate with the Press Service and the Radio Service of the Office of Information in preparing and furnishing informational material.

Through three extension specialists, cooperatively maintained, dealing respectively with plant-disease control, horticulture, and agronomy, cooperation was continued with the Department's Extension Service and the State agricultural extension services in making available to farmers the practical benefits of research.

LIST OF PUBLICATIONS

CEREALS

The utilization of Wabash clay (gumbo) soils in crop production. By B. M. King. Mo. Agr. Expt. Sta. Research Bull. 254. (In cooperation.)

A seed dropper for cereal nursery rows. (Note.) By L. C. Burnett. Jour. Amer. Soc. Agron. 29: 419–420.

The best small grains for your Nebraska farm. By C. A. Suneson. Nebr. State Bd. Agr. Ann. Rept. 1936: 206–213. (In cooperation.)

Small grain experiments. By E. E. Hall and F. M. Harrell. S. C. Agr. Expt. Sta Ann. Rept. 49: 79–83. (In cooperation.)

Influence of environment during maturation on the disease reaction and yield of wheat and barley. By B. B. Bayles. Jour. Agr. Research 53: 717–748.

Influence of stripe rust on growth, water economy, and yield of wheat and barley. By W. M. Bever. Jour. Agr. Research 54: 375–385.

Relative susceptibility of certain species of Gramineae to *Cercosporella herpotrichoides*. By R. Sprague. Jour. Agr. Research 53: 659–670.

BARLEY

Barley production in Colorado, 1928–1935. By D. W. Robertson, D. Koonce, J. J. Curtis, and J. F. Brandon. Colo. Agr. Expt. Sta. Bull. 431. (In cooperation.)

The time factor in pollen-tube growth and fertilization in barley. By M. N. Pope. Jour. Agr. Research 54: 525–529.

Factors influencing infection of barley by loose smut. By R. W. Leukel. Phytopathology 26: 630–642.

A method of inoculating seed barley with black loose smut for use in studies on physiologic races. (Note.) By V. F. Tapke. Phytopathology 27: 115–116.

Pathogenic strains in *Ustilago nigra* (Note.) By V. F. Tapke. Phytopathology 26: 1033.

Barley and malt studies. II. Experimental malting of barleys grown in 1935. By J. G. Dickson, H. L. Shands, A. D. Dickson, and B. A. Burkhart. Cereal Chem. 14: 316–327. (With Univ. Wis.)

The status of barley improvement from a technical and scientific standpoint. By J. G. Dickson. Amer. Brewer 69 (11): 75–82.

CORN

Maize as a measure of Indian skill. By J. H. Kempton. N. Mex. Univ. Bull. 296 (Anthropol. Ser. v. 1, no. 5): 19–28.

Corn varieties, breeding and culture. By H. B. Brown and H. Stoneberg. La. Agr. Expt. Sta. Bull. 283: 20–30. (In cooperation.)

Developmental morphology of the caryopsis in maize. By L. F. Randolph. Jour. Agr. Research 53: 881–916.

Effect of Luteus genes on longevity of seed in maize. By M. G. Weiss and J. B. Wentz. Jour. Amer. Soc. Agron. 29: 63–75. (With Iowa State Col.)

The effect of varying gene dosage on aleurone colour in maize. By M. M. Rhoades. Jour. Genetics 33: 347–354.

Genetic effects of ultra-violet radiation in maize. I. Unfiltered radiation. II. Filtered radiations. III. Effects of nearly monochromatic λ 2537, and comparison of effects of X-ray and ultra-violet treatment. By L. J. Stadler and G. F. Sprague. Natl. Acad. Sci. Proc. 22: 572–591. (With Mo. Agr. Expt. Sta.)

Note on the origin of triploidy in maize. By M. M. Rhoades. Jour. Genetics 33: 355–357.

A second-chromosome gene, Y_3, producing yellow endosperm color in maize. By H. S. Perry and G. F. Sprague. Jour. Amer. Soc. Agron. 28: 990–996.

Hybrid vigor and growth rates in a maize cross and its reciprocal. By G. F. Sprague. Jour. Agr. Research 53: 819–830.

Hybrid corn leads for the sixth consecutive year. By G. H. Stringfield. Ohio Agr. Expt. Sta. (55th Ann. Rept.) Bull. 579: 26–27. (In cooperation.)

Corn grown successfully in tank cultures. By J. D. Sayre and V. H. Morris. Ohio Agr. Expt. Sta. (55th Ann. Rept.) Bull. 579: 32–33. (In cooperation.)

Methods used in the determination of relative amounts of ear rot in dent corn. By P. E. Hoppe and J. R. Holbert. Jour. Amer. Soc. Agron. 28: 810–819.

A method for studying resistance to drought injury in inbred lines of maize. By J. W. Hunter, H. H. Laude, and A. M. Brunson. Jour. Amer. Soc. Agron. 28: 694–698. (With J. C. Robinson Seed Co., Waterloo, Nebr., and Kans. State Col.)

Resistance to corn earworm injury in the Charleston, South Carolina, area. By C. F. Poole. Amer. Soc. Hort. Sci. Proc. 34: 566–569.

Illinois corn performance tests. Results for 1935, 1936. By G. H. Dungan, J. R. Holbert, W. J. Mumm, J. H. Bigger, and A. L. Lang. Ill. Agr. Expt. Sta. Bull. 427, 429. (With Ill. Agr. Expt. Sta. and Ill. Nat. Hist. Survey.)

The 1936 Iowa corn yield test. By M. M. Rhoades and J. L. Robinson. Iowa Agr. Expt. Sta. Bull. 355. (With Iowa Corn and Small Grain Growers' Assoc.)

OATS

Oat production in Colorado 1928–1935. By D. W. Robertson, D. Koonce, J. J. Curtis, and J. F. Brandon. Colo. Expt. Sta. Bull. 430. (In cooperation.)

Influence of certain oat varieties on their F_1 progeny. By F. A. Coffman and H. Stevens. Jour. Amer. Soc. Agron. 29: 314–323. (With Idaho Agr. Expt. Sta.)

Specific hybridization, a probable method for producing hardier winter oats. (Note.) By F. A. Coffman. Jour. Amer. Soc. Agron. 29: 79–81.

The occurrence of striped-leaved plants from a cross between two varieties of oats. By H. H. Love and W. T. Craig. Jour. Amer. Soc. Agron. 28: 1005–1011. (With Cornell Univ.)

A study of the reaction of F_1 oats hybrids and their respective parental lines to inoculation with smuts and rusts. By H. B. Humphrey and F. A. Coffman. Phytopathology 27: 183–189.

A race of crown rust to which the Victoria oat variety is susceptible. (Note.) By H. C. Murphy and M. N. Levine. Phytopathology 26: 1087–1089. (With Iowa and Minn. Agr. Expt. Stas.)

The effect of latent infection on the smut-resistant Markton oat. By H. Stevens. Jour. Amer. Soc. Agron. 28: 711–713.

Seed treatment experiments with oats naturally and artificially inoculated with smuts. By R. W. Leukel. U. S. Dept. Agr. Tech. Bull. 568.

RICE

Studies on growth in rice. By C. R. Adair. Jour. Amer. Soc. Agron. 28: 506–514.

Effect of date of seeding on the length of the growing period of rice. By J. M. Jenkins. La. Agr. Expt. Sta. Bull. 277. (In cooperation.) Also abridged, in Rice, Sugar and Coffee Jour. 39 (11): 10–11.

The stunt disease of Japanese rice, the first plant virosis shown to be transmitted by an insect vector. By S. Katsura. Phytopathology 26: 887–895.

Fungi isolated from discolored rice kernels. By E. C. Tullis. U. S. Dept. Agr. Tech. Bull. 540. (With Ark., La., and Tex. Agr. Expt. Stas.)

SORGHUM

Identification, history, and distribution of common sorghum varieties. By H. N. Vinall, J. C. Stephens, and J. H. Martin. U. S. Dept. Agr. Tech. Bull. 506.

Grain and forage sorghums for Nebraska. By A. F. Swanson. Nebr. State Bd. Agr. Ann. Rept. 1936: 194–206. (In cooperation.)

Effect of germination and seed size on sorghum stands. By A. F. Swanson and R. Hunter. Jour. Amer. Soc. Agron. 28: 997–1004. (With Ft. Hays Branch, Kans. Agr. Expt. Sta.)

Leaf number of sorghum stalks. By J. B. Sieglinger. Jour. Amer. Soc. Agron. 28: 636–642.

Growing and feeding grain sorghums. By J. H. Martin, J. S. Cole, and A. T. Semple. U. S. Dept. Agr. Farmers' Bull. 1764. (With Bur. Anim. Indus.)

Pythium root rot of milo. By C. Elliott, L. E. Melchers, C. L. Lefebvre, and F. A. Wagner. Jour. Agr. Research 54: 797–834. (With Kans. State Col. and Kans. Agr. Expt. Sta.)

Effect of several varieties of sorghum and other host plants on biology of the chinch bug. By R. G. Dahms, R. O. Snelling, and F. A. Fenton. Jour. Econ. Ent. 29: 1147–1153. (With Bur. Ent. and Plant Quarantine and Okla. Agr. Expt. Sta.)

Third generation and method of migration of chinch bug in southwestern Oklahoma. By R. O. Snelling. Jour. Econ. Ent. 29: 797–803.

TEOSINTE

Morphological characters of teosinte chromosomes. By A. E. Longley. Jour. Agr. Research 54: 835–862.

Teosinte in Guatemala. Report of the agricultural expedition to Guatemala, El Salvador, and Chiapas, Mexico. By J. H. Kempton and W. Popenoe. Carnegie Inst. Wash. Pub. 483: 199–218. (With United Fruit Co.)

WHEAT

Distribution of the varieties and classes of wheat in the United States in 1924. By J. A. Clark and K. S. Quisenberry. U. S. Dept. Agr. Cir. 424.

Registration of improved wheat varieties, X. By J. A. Clark. Jour. Amer. Soc. Agron. 28: 1017–1018.

The carotene content of wheat varieties in the Pacific Northwest. By C. C. Fifield, S. R. Snider, and H. Stevens. Cereal Chem. 13: 463–469. (With Bur. Agr. Econ.)

Rate of water loss in wheat varieties and resistance to artificial drouth. By B. B. Bayles, J. W. Taylor, and A. T. Bartel. Jour. Amer. Soc. Agron. 29: 40–52.

Changes in breaking strength of straw of wheat varieties from heading to maturity. By A. T. Bartel. Jour. Amer. Soc. Agron. 29: 153–156.

Developing and testing improved varieties of wheat. By K. S. Quisenberry. Cereal Chem. 13: 712–718. Also in Bakers Tech. Digest 11: 167–168, 172.

Cytogenetic studies in *Triticum monococcum* L. and *T. aegilopoides* Bal. By L. Smith. Mo. Agr. Expt. Sta. Research Bull. 248. (In cooperation.)

Inheritance of complementary dwarfing factors in wheat. By V. H. Florell and J. F. Martin. Jour. Agr. Research 53: 151–160.

Emasculation of wheat by chilling. By C. A. Suneson. Jour. Amer. Soc. Agron. 29: 247–249.

Effect of defoliation upon the cold resistance of winter wheat. By C. A. Suneson and G. L. Peltier. Jour. Amer. Soc. Agron. 28: 807–809. (With Nebr. Agr. Expt. Sta.)

Effect of source, quality, and condition of seed upon the cold resistance of winter wheats. By C. A. Suneson and G. L. Peltier. Jour. Amer. Soc. Agron. 28: 687–693. (With Nebr. Agr. Expt. Sta.)

Reducing the risk in wheat farming in western Kansas. By A. L. Hallsted. Kans. State Bd. Agr. Bien. Rept. 30. (Preprint, 13 p.) (In cooperation.)

Ecological factors in north Texas related to the 1935 stem rust epidemic. By I. M. Atkins. Plant Disease Reptr. Sup. 93. [Mimeographed.]

The stem rust epidemic of 1935 in Kansas. By C. O. Johnston, L. E. Melchers, H. H. Laude, and J. H. Parker. Plant Disease Reptr. Sup. 92. (With Kans. Agr. Expt. Sta.) [Mimeographed.]

The degree of bunt resistance necessary in a commercial wheat. (Note.) By G. A. Wiebe and F. N. Briggs. Phytopathology 27: 313–314. (With Univ. Calif.)

Reaction of wheat varieties to composites of races of bunt occurring in the Pacific Northwest. By J. F. Martin. Jour. Amer. Soc. Agron. 28: 672–682.

Studies on the control and other aspects of bunt of wheat. By C. S. Holton and F. D. Heald. Wash. Agr. Expt. Sta. Bull. 339. (In cooperation.)

COTTON

Cotton, other fiber crops, and sugar beets. By H. B. Brown, J. R. Cotton, and D. C. Neal. La. Agr. Expt. Sta. Bull. 283: 5–20. (In cooperation.)

Cytogenic notes on cotton and cotton relatives. II. By J. M. Webber. Science 84: 378.

Piedmont station—Statesville, N. C. Cotton Breeding Station. By J. W. Hendricks. N. C. Dept. Agr. Rept. 1934/36: 99–100. (In cooperation.)

Cooperative breeding and varietal studies of cotton. By W. H. Jenkins and E. E. Hall. S. C. Agr. Expt. Sta. Ann. Rept. 49: 83–85. (In cooperation.)

Cotton breeding. By E. D. Kyzer and W. H. Jenkins. S. C. Agr. Expt. Sta. Ann. Rept. 49: 72–73. (In cooperation.)

Cotton production studies. By E. E. Hall and F. M. Harrell. S. C. Agr. Expt. Sta. Ann. Rept. 49: 74–79. (In cooperation.)

A further note on plant competition. In his Row competition and its relation to cotton varieties of unlike plant growth. By N. I. Hancock. Jour. Amer. Soc. Agron. 28: 954–956. (With Tenn. Agr. Expt. Sta.)

Carbohydrate content of cotton plants at different growth periods and the influence of fertilizers. By D. R. Ergle. Jour. Amer. Soc. Agron. 28: 775–786.

Fertilizer placement experiments with cotton. By N. McKaig, Jr. S. C. Agr. Expt. Sta. Ann. Rept. 49: 119–121. (In cooperation.)

Cotton fertilizers for Georgia soils. By R. P. Bledsoe, S. V. Stacy, and J. J. Skinner. Ga. Expt. Sta. Bull. 196. (In cooperation.)

Pee Dee Experiment Station. By E. E. Hall. S. C. Agr. Expt. Sta. Ann. Rept. 49: 73–74. (In cooperation.)

Chemical dust treatment of cottonseed for planting purposes. By H. P. Smith, D. L. Jones, D. T. Killough, and H. C. McNamara. Tex. Agr. Expt. Sta. Bull. 531. (In cooperation.)

The comparative rôle of certain nematodes and fungi in the etiology of damping off, or soreshin, of cotton. By C. H. Arndt and J. R. Christie. Phytopathology 27: 569–572. (With S. C. Agr. Expt. Sta.)

A method for the control of cotton root rot in the irrigated Southwest. By C. J. King. U. S. Dept. Agr. Cir. 425.

Concentration of ammonia necessary in a low-lime phase of Houston clay soil to kill the cotton root-rot fungus, *Phymatotrichum omnivorum*. By D. C. Neal and E. R. Collins. Phytopathology 26: 1030–1032.

Variability of fiber length in a relatively uniform strain of cotton. By T. R. Richmond and H. J. Fulton. Jour. Agr. Research 53: 749–763.

El algodon "Sea Island" en Puerto Rico y su relacion con la produccion en los Estados Unidos continentales. By W. H. Jenkins. Rev. Agr. Puerto Rico 28: 436–448.

DRUG AND RELATED PLANTS

Insect damage to seeds of *Cracca virginiana* L. By J. S. Yip. Jour. Econ. Ent. 29: 622–629.

Observations on the menthol content of oil of Japanese mint under continuous cultivation in one locality. By A. F. Sievers and M. S. Lowman. Jour. Amer. Pharm. Assoc. 26: 286–288.

DRY-LAND AGRICULTURE

Dry-land crops at the Tucumcari Field Station. By D. R. Burnham and J. S. Cole. N. Mex. Agr. Expt. Sta. Bull. 244. (In cooperation.)

Crop rotation and tillage experiments at the Northern Great Plains Field Station. Mandan, N. Dak. By J. T. Sarvis and J. C. Thysell. U. S. Dept. Agr. Tech. Bull. 536.

Results of field crop, shelterbelt, and orchard investigations at the United States Dry Land Field Station, Ardmore, S. Dak., 1911–32. By O. R. Mathews and V. I. Clark. U. S. Dept. Agr. Cir. 421.

Maintenance of organic matter in dry-land soils. By L. L. Zook. Nebr. Potato Impr. Assoc. Ann. Rept. 17: 61–71. Also in Nebr. State Bd. Agr. Ann. Rept. 1936: 737–747.

Preventing soil blowing on the southern Great Plains. By E. F. Chilcott. U. S. Dept. Agr. Farmers' Bull. 1771.

Pump irrigation at the North Platte Experimental Substation. By H. E. Weakly. Nebr. Agr. Expt. Sta. Bull. 301. (In cooperation.)

FLAX

Effect of age, condition, and temperature on the germination of flaxseed. By A. C. Dillman and E. H. Toole. Jour. Amer. Soc. Agron. 29: 23–29.

Fiber flax in Oregon. By B. B. Robinson. Oreg. Agr. Expt. Sta. Cir. 118. (In cooperation.)

Experimental studies in growing, decorticating, chemical degumming, and manufacture of flax into yarns and papers. [Report of Flax Committee.] By H. H. Willis, L. H. Dewey, and others. 78 pp. Washington, D. C., The Textile Foundation, Inc. [Mimeographed.]

FORAGE CROPS

Pasture experiments. By W. E. Stokes, G. E. Ritchey, and W. A. Leukel. Fla. Agr. Expt. Sta. Ann. Rept. 1935–36: 37–38. (In cooperation.)

The calcium and phosphorus content of pasture herbage and of various pasture species as affected by fertilization and liming. By W. H. Pierre and R. R. Robinson. Jour. Amer. Soc. Agron. 29: 477–497. (With W. Va. Agr. Expt. Sta.)

A comparison of grazing and clipping for determining the response of permanent pastures to fertilization. By R. R. Robinson, W. H. Pierre, and R. A. Ackerman. Jour. Amer. Soc. Agron. 29: 349–359. (With W. Va. Agr. Expt. Sta.)

Effect of method and rate of grazing on beef production and plant population of pastures at Beltsville, Md. By M. A. Hein and A. C. Cook. U. S. Dept. Agr. Tech. Bull. 538. (With Bur. Anim. Indus.)

Permanent pastures for cattle production in the rice area of southwestern Louisiana. By J. M. Jenkins. La. Agr. Expt. Sta. Bull. 276. (In cooperation.)

Coastal Plain Station—Willard, N. C. Forage crops. By C. T. Dearing. N. C. Dept. Agr. Rept. 1934–36: 79. (In cooperation.)

Piedmont Station—Statesville, N. C. Forage crops. By J. W. Hendricks. N. C. Dept. Agr. Rept. 1934–36: 98–99. (In cooperation.)

Extraction of the nitrogenous materials from dried grass. By H. L. Wilkins. Science 85: 526–527.

Cover crops for soil conservation. By W. F. Kell and R. McKee. U. S. Dept. Agr. Farmers' Bull. 1758. (With Soil Conserv. Serv.)

LEGUMES

Effect of maturity on chemical composition of leguminous forage plants. By A. J. Pieters. Jour. Amer. Soc. Agron. 29: 436–440.

Crop rotation studies with corn, cotton, crotalaria, and Austrian peas. By W. E. Stokes, P. J. Camp, and G. E. Ritchey. Fla. Agr. Expt. Sta. Ann. Rept. 1935–36: 38–39. (In cooperation.)

Green manure studies. By W. A. Leukel and G. E. Ritchey. Fla. Agr. Expt. Sta. Ann. Rept. 1935–36: 40. (In cooperation.)

A green manure fertilizer study on Norfolk sand. By J. E. Adams, E. M. Roller, and H. M. Boggs. Soil Sci. 42: 175–186.

Variety test work with field crops. By W. E. Stokes, G. E. Ritchey, and J. P. Camp. Fla. Agr. Expt. Sta. Ann. Rept. 1935–36: 39–40. (In cooperation.)

Alfalfa dwarf, a virus disease transmissible by grafting. By J. L. Weimer. Jour. Agr. Research 53: 333–347.

The possibility of insect transmission of alfalfa dwarf. By J. L. Weimer. Phytopathology 27: 697–702.

A foliage yellowing and floral injury of alfalfa associated with heat and drought. By F. R. Jones. Phytopathology 27: 729–730.

Effect of leaf-hopper yellowing upon the carotene content of alfalfa. By H. W. Johnson. Phytopathology 26: 1061–1063.

Injury to alfalfa and red clover by the potato leafhopper. By F. W. Poos and H. W. Johnson. Jour. Econ. Ent. 29: 325–331. (With Bur. Ent. and Plant Quarantine.)

A leaf spot disease of red and white clovers. By O. F. Smith. Jour. Agr. Research 54: 591–599.

Ladino clover for western Oregon. By H. A. Schoth. Oreg. Agr. Expt. Sta. Cir. 117. (In cooperation.)

Whiteclover. By E. A. Hollowell. U. S. Dept. Agr. Leafl. 119.

A study of crotalaria as a forage crop. By W. E. Stokes and G. E. Ritchey. Fla. Agr. Expt. Sta. Ann. Rept. 1935–36: 43–44. (In cooperation.)

A study of the relative adaptation of certain varieties of soybeans. By J. M. Poehlman. Mo. Agr. Expt. Sta. Research Bull. 255. (In cooperation.)

Soybeans in the United States in relation to world production and trade. By W. J. Morse. Amer. Soybean Assoc. Proc. 16: 55–56, 58–60.

GRASSES

Drought survival of native grass species in the central and southern Great Plains, 1935. By D. A. Savage. U. S. Dept. Agr. Tech. Bull. 549.

The effect of fertilizer applications on the composition of pasture grasses. By H. N. Vinall and H. L. Wilkins. Jour. Amer. Soc. Agron. 82: 562–569.

Crop adaptation studies. By W. E. Stokes and G. E. Ritchey. Fla. Agr. Expt. Sta. Ann. Rept. 1935–36: 42. (In cooperation.)

Pasture grasses. By W. F. Ward and G. E. Ritchey. Fla. Agr. Expt. Sta. Ann. Rept. 1935–36: 156–157. (In cooperation.)

Timothy selection for improvement in quality of hay. By M. W. Evans and J. E. Ely. Jour. Amer. Soc. Agron. 28: 941–947. (With Ohio Agr. Expt. Sta.)

(See also Systematic Botany, Grasses)

FOREST TREE DISEASES

Shade tree diseases. (Note.) By R. P. Marshall. Jour. Forestry 35: 409–411.

Estimating the length of time that trees have been dead in northern New England. By P. Spaulding. Jour. Forestry 35: 393–395.

Distribution and prevalence of ozonium root rot in the shelter-belt zone of Texas. By G. L. Peltier. Phytopathology 27: 145–158.

New hosts and distribution of *Rehmiellopsis bohemica*. (Note.) By A. M. Waterman. Phytopathology 27: 734–736.

Reduction of nectria canker in hardwood forests of the Northeast. By T. J. Grant. Northeastern Forest Expt. Sta. Occas. Paper No. 6.

Decay in merchantable oak, yellow poplar, and basswood in the Appalachian region. By G. H. Hepting and G. G. Hedgcock. U. S. Dept. Agr. Tech. Bull. 570.

Forest plantings of Asiatic chestnuts require good sites. (Note.) By J. D. Diller. Jour. Forestry 35: 85–86.

Factors affecting Asiatic chestnuts in forest plantations. By J. L. Bedwell. Jour. Forestry 35: 258–262.

Status of work with blight-resistant chestnuts. By R. B. Clapper and G. F. Gravatt. North. Nut Growers Assoc. Proc. 27: 58–60.

The Dutch elm disease in Europe. By R. K. Beattie. Amer. Forests 43: 159–161, 201.

Variation in mass isolates and monoconidium progenies of *Ceratostomella ulmi*. By J. M. Walter. Jour. Agr. Research 54: 509–523.

A new species of *Dothiorella* causing die-back of elm. By A. F. Verrall and C. May. Mycologia 29: 321–324.

A die-back of Douglas fir. (Note.) By A. M. Waterman and J. A. Miller. Phytopathology 26: 804–805. (With Osborn Bot. Lab. Yale Univ.)

Progressive effects of *Polyporus versicolor* on the physical and chemical properties of red gum sapwood. By T. C. Scheffer. U. S. Dept. Agr. Tech. Bull. 527.

A leaf and twig disease of hemlock caused by a new species of *Rosellinia*. By G. H. Hepting and R. W. Davidson. Phytopathology 27: 305–310.

Larch canker. By G. G. Hahn. Natl. Shade Tree Conf. Proc. 12: 120–127.

The European larch canker and its relation to certain other cankers of conifers in the United States. By G. G. Hahn and T. T. Ayers. Jour. Forestry 34: 898–908.

A seedling wilt of black locust caused by *Phytophthora parasitica*. By E. B. Lambert and B. S. Crandall. Jour. Agr. Research 53: 467–476.

The dissemination of *Septoria acicola* and the effect of grass fires on it in pine needles. By A. F. Verrell. Phytopathology 26: 1021–1024.

The tympanis canker of red pine. By J. R. Hansbrough. Yale Univ. School Forestry Bull. 43. (In cooperation.)

Zygosaccharomyces pini, a new species of yeast associated with bark beetles in pines. By E. C. Holst. Jour. Agr. Research 53: 513–518.

Disease killing plane trees. By L. W. R. Jackson and B. Sleeth. Forest Leaves 27 (2): 5–6, 14–15.

Immunity of Viking red currant from white pine blister rust under field conditions. By G. G. Hahn. Phytopathology 26: 860–875.

FRUIT

Bud mutations in horticultural crops. By A. D. Shamel and C. S. Pomeroy. Jour. Heredity 27: 487–494.

Effect of carbon dioxide on the carbohydrates and acidity of fruits and vegetables in storage. By E. V. Miller and O. J. Dowd. Jour. Agr. Research 53: 1–17.

The determination of the internal gases of plant tissues. By C. W. Culpepper, H. H. Moon, and J. M. Lutz. Science 84: 398–400.

Fruit and vegetable diseases on the Chicago market in 1935. By G. B. Ramsey. Plant Disease Reptr. Sup. 98. (Mimeographed.)

Transport of root-forming hormone in woody cuttings. By W. C. Cooper. Plant Physiol. 11: 779–793.

Coastal Plain Station—Willard, N. C. Horticulture. By C. T. Dearing. N. C. Dept. Agr. Rept. 1934–36: 80–81. (In cooperation.)

Diagnosing the lack of fertilizer elements for orchard trees. By J. H. Weinberger. Md. State Hort. Soc. Proc. 39: 3–7.

Recent developments in fungicides: Spray materials. By J. W. Roberts. Bot. Rev. 2: 586–600.

Protection of apples and pears in transit from the Pacific Northwest during the winter months. By E. D. Mallison, E. A. Gorman, Jr., and W. V. Hukill. U. S. Dept. Agr. Tech. Bull. 550.

Market diseases of fruits and vegetables: Peaches, plums, cherries, and other stone fruits. By D. H. Rose, D. F. Fisher, C. Brooks, and C. O Bratley. U. S. Dept. Agr. Misc. Pub. 228.

APPLE

Etiolation as a method of rooting apple variety stem cuttings. By F. E. Gardner. Amer. Soc. Hort. Sci Pr c. 34: 32 –329.

The relation of fruit thinning to size and color of fruit and the bearing habits of apple trees. By L. A. Fletcher. Md. State Hort. Soc. Proc. 38: 4–7. Also in Md. Agr. Soc. Rept. 20: 145–148.

Soil moisture in orchards and irrigation in the East. By J. R. Magness. N. J. State Hort. Soc. News 18: 877–879. Also in Ill. State Hort. Soc. Trans. 70: 213–220; N. Y. State Hort. Soc. Proc. 82: 124–129.

The orchard soil moisture problem in the Missouri Valley. By J. R. Magness. Kans. State Hort. Soc. Bien. Rept. 43: 101–106. Also in Nebr. State Bd. Agr. Ann. Rept. 1936: 581–587.

Relation of soil moisture to cracking and related troubles of apples. By J. R. Magness. Md. State Hort. Soc. Proc. 38: 13–17. Also in Md. Agr. Soc. Rept. 20: 154–158.

Effect of nutritional treatments on internal cork of apples. By J. R. Magness, E. S. Degman, L. P. Batjer, and L. O. Regeimbal. Amer. Soc. Hort. Sci. Proc. 34: 206–209.

Incidence and development of apple scab on fruit during the late summer and while in storage. By C. O. Bratley. U. S. Dept. Agr. Tech. Bull. 563.

Sclerotium rolfsii as a disease of nursery apple trees. (Note.) By J. S. Cooley. Phytopathology 26: 1081–1083.

Harvesting and handling fruit. By J. R. Magness. N. Y. State Hort. Soc. Proc. 82: 156–160.

Distribution of acetaldehyde and alcohol in the apple fruit. By E. V. Miller. Jour. Agr. Research 53: 49–55.

Distribution of total soluble solids and catalase in different parts of Jonathan apples. By P. L. Harding. Jour. Agr. Research 53: 43–48.

Soft scald of Jonathan apples in relation to respiration. By M. H. Haller and J. M. Lutz. Amer. Soc. Hort. Sci. Proc. 34: 173–176.

Variability in lead residues on apples. By M. H. Haller, C. C. Cassil, and E. Gould. Jour. Econ. Ent. 30: 174–179. (With Bur. Ent. and Plant Quarantine and W. Va. Agr. Expt. Sta.)

Present equipment and methods for effective and safe washing of eastern apples. By D. F. Fisher. Md. State Hort. Soc. Proc. 39: 8–14.

Influence of packing and handling methods on condition of apples barreled for export. By P. L. Harding, J. M. Lutz, and D. H. Rose. U. S. Dept. Agr. Tech. Bull. 559.

Transportation of apples from the Shenandoah-Cumberland section to overseas markets. By P. L. Harding and C. L. Powell. U. S. Dept. Agr. Tech. Bull. 523.

AVOCADO

Bud selection in avocado varieties. By A. D. Shamel. Calif. Avocado Assoc. Yearbook 1936: 146–149.

The parent Fuerte avocado tree. By A. D. Shamel. Calif. Avocado Assoc. Yearbook 1936: 86–92.

The parent Fuerte avocado. Three quarters of California avocado industry traces to Mexican trees. By A. D. Shamel. Jour. Heredity 28: 180–182.

Avocado spraying results for 1934. By H. E. Stevens. Fla. State Hort. Soc. Proc. 49: 130–132.

CITRUS

Use of soil-moisture and fruit-growth records for checking irrigation practices in citrus orchards. By C. A. Taylor and J. R. Furr. U. S Dept. Agr. Cir. 426. (With Bur. Agr. Engin.)

Harvesting and handling citrus fruits in the Gulf States. By J. R. Winston. U. S. Dept. Agr. Farmers' Bull. 1763.

Areolate spot; Citrus scab. By H. S. Fawcett and A. E. Jenkins. In Fawcett, H. S., Citrus diseases and their control. 2d ed., rev. p. 290–291, 529–538, 540, 543–549.

Behavior of citrus fruit under special respiratory conditions as an expedient index of vitality. By E. M. Harvey and G. L. Rygg. Plant Physiol. 11: 647–651.

A method of harvesting grapefruit to retard stem-end rot. By J. R. Winston. U. S. Dept. Agr. Cir. 396.

Bud selection in Eureka and Lisbon lemons and progeny tests of bud variations. By A. D. Shamel, C. S. Pomeroy, and R. E. Caryl. U. S. Dept. Agr. Tech. Bull. 531.

Sweet orange fruit scab caused by *Elsinoë australis*. By A. A. Bitancourt and A. E. Jenkins. Jour. Agr. Research 54: 1–18. (With Inst. Biol. São Paulo, Brazil.)

Perfect stage of the sweet orange fruit scab fungus. By A. A. Bitancourt and A. E. Jenkins. Mycologia 28: 489–492. (With Inst. Biol. São Paulo, Brazil.)

DATE

Fruit thinning experiments with Deglet Noor dates. By R. W. Nixon and C. L. Crawford. Amer. Soc. Hort. Sci. Proc. 34: 107–115.

GRAPE

Hastening the production of fruit in grape hybridizing work. By E. Snyder and F. N. Harmon. Amer. Soc. Hort. Sci. Proc. 34: 426–427.

Susceptibility of grape rootstocks to root knot nematode. By E. Snyder. U. S. Dept. Agr. Cir. 405.

MANGO

Control of mango blossom-blight and anthracnose. By H. E. Stevens. Fla. State Hort. Soc. Proc. 49: 125–130.

PAPAYA

Rooting of papaya cuttings. By H. P. Traub and L. C. Marshall. Amer. Soc. Hort. Sci. Proc. 34: 291–294.

PEACH

Cover crops for the peach orchard: their handling and effect on the trees and fruit. By F. P. Cullinan. Md. State Hort. Soc. Proc. 38: 8–13. Also in Md. Agr. Soc. Rept. 20: 149–154.

Some effects of four years of cover crops in a young peach orchard. By F. P. Cullinan and J. H. Weinberger. Amer. Soc. Hort. Sci. Proc. 34: 242–246.

Symptoms of some mineral deficiencies in one-year Elberta peach trees. By J. H. Weinberger and F. P. Cullinan. Amer. Soc. Hort. Sci. Proc. 34: 249–254.

Peach mosaic; its identification and control. By L. M. Hutchins, E. W. Bodine, and H. H. Thornberry. U. S. Dept. Agr. Cir. 427. (With Colo. Expt. Sta. and Citrus Expt. Sta. Univ. Calif.)

The peach mosaic disease. By L. M. Hutchins. Calif. State Dept. Agr. Spec. Pub. 145: 60–61.

Nematode-resistant peach rootstocks of superior vigor. By L. M. Hutchins. Amer. Soc. Hort. Sci. Proc. 34: 330–338.

Infection studies with *Sclerotinia fructicola* on brushed and nonbrushed peaches. By M. A. Smith. Phytopathology 26: 1056–1060.

PEAR

Relative efficiency of spur and shoot leaves for fruit growth of pears. By W. W. Aldrich. Amer. Soc. Hort. Sci. Proc. 34: 227–232.

Pear pruning in relation to the number, size and appearance of fruits. By W. W. Aldrich. Oreg. State Hort. Soc. Proc. 28: 109–116.

PLUM

Second report of progress on prune russet ("scab") and its control. By P. W. Miller. Oreg. State Hort. Soc. Proc. 28: 90–108.

SMALL FRUITS

New developments in small fruits. By G. M. Darrow. Md. State Hort. Soc. Proc. 38: 50–53. Also in Md. Agr. Soc. Rept. 20: 191–194.

Interrelation of temperature and photoperiodism in the production of fruit-buds and runners in the strawberry. By G. M. Darrow. Amer. Soc. Hort. Sci. Proc. 34: 360–363.

The distribution, cause, and relative importance of cranberry fruit rots in Massachusetts in 1932 and 1933, and their control by spraying. By H. F. Bergman and M. S. Wilcox. Phytopathology 26: 656–663.

Some effects of different storage temperatures on the keeping of cranberries. By R. C. Wright, J. B. Demaree, and M. S. Wilcox. Amer. Soc. Hort. Sci. Proc. 34: 397–401.

Breaking the rest period of the strawberry by long days at high temperatures. By G. M. Darrow. Science 85: 391–392.

Notes on the strawberry strains of the bud and leaf nematode, *Aphelenchoides fragariae*, I. By J. R. Christie and L. Crossman. Helminthol. Soc. Wash. Proc. 3: 69–72.

Handling, precooling, and transportation of Florida strawberries. By D. H. Rose and E. A. Gorman. U. S. Dept. Agr. Tech. Bull. 525.

MYCOLOGY

Diseases of plants. By H. A. Edson. Amer. Year Book 1936: 434–436.

Diseases of plants in the United States in 1935. By H. A. Edson and J. I. Wood. Plant Disease Reptr. Sup. 96. [Mimeographed.]

Estimates of crop losses from diseases in the United States in 1935. By H. A. Edson, J. I. Wood, and N. W. Nance. Plant Disease Reptr. Sup. 94. [Mimeographed.]

Crop losses from plant diseases in the United States in 1936. By H. A. Edson and J. I. Wood. Plant Disease Reptr. Sup. 100. [Mimeographed.]

Recent fluctuations in plant diseases in the United States. By N. E. Stevens and J. I. Wood. Bot. Rev. 3: 277–306.

Some effects of plant diseases on variability of yields. By C. Hartley and A. R. Gravatt. Phytopathology 27: 159–171.

Mycological notes. I. By C. L. Shear. Mycologia 29: 355–363.

The new fungus names proposed by C. G. Lloyd. By J. A. Stevenson and E. K. Cash. Lloyd Libr. Bull. 35 (Mycol. Ser. 8).

A basis for mycogeography. By W. W. Diehl. Jour. Wash. Acad. Sci. 27: 244–254.

A note on the temperature relations of certain fungi. By N. E. Stevens. Mycologia 28: 510–513.

Natural history of Plummers Island, Maryland. V. Fungi. By J. A. Stevenson and E. M. Ermold. Biol. Soc. Wash. Proc. 49: 123–132.

A preliminary list of the fungi of the Shenandoah National Park. By J. A. Stevenson. Claytonia 3: 21–28, 31–35.

Effects of conditions in the stratosphere on spores of fungi. By F. C. Meier. Natl. Geogr. Soc. Contributed Tech. Papers Stratosphere Ser. 2: 152–153. (With Weather Bur.)

Some new Colorado Discomycetes. By E. K. Cash. Mycologia 28: 297–306.

New conidial Phycomycetes destructive to terricolous Amoebae. By C. Drechsler. Mycologia 28: 363–389.

New Zoopagaceae destructive to soil rhizopods. By C. Drechsler. Mycologia 29: 229–249.

The life histories of *Botryosphaeria melanops* and *Massaria platani*. By C. L. Shear and R. W. Davidson. Mycologia 28: 476–482.

The synonymy of *Botrytis rileyi* Farlow. By V. K. Charles. Mycologia 28: 397–398.

Cenangium molliusculum. By E. K. Cash. Mycologia 29: 303–304.

Organization of the unwalled ascus in two species of *Ceratostomella*. By C. F. Andrus and L. L. Harter. Jour. Agr. Research 54: 19–46.

A preliminary note on sexuality in *Ceratostomella ulmi*. (Note.) By R. U. Swingle. Phytopathology 26: 925–927.

A method of separating the teliospores of *Cronartium ribicola*. (Note.) By R. K. Pierson. Phytopathology 26: 923–925. (With Univ. Idaho.)

A *Fusarium*-like species of *Dactylella* capturing and consuming testaceous rhizopods. By C. Drechsler. Jour. Wash. Acad. Sci. 26: 397–404.

Intraspecific and interspecific aversion in *Diplodia*. By P. E. Hoppe. Jour. Agr. Research 53: 671–680.

Comparações culturaes e inoculações em videira com os fungos *Elsinoë fawcetti*, e ampelina, e veneta. By A. E. Jenkins. Arch. Inst. Biol. (São Paulo, Brazil) 7: 23–32.

A cytological study of *Erysiphe polygoni* on delphinium. By R. F. Allen. Jour. Agr. Research 53: 801–818.

The tolerance of *Erysiphe polygoni* and certain other powdery mildews to low humidity. By C. E. Yarwood. Phytopathology 26: 845–859. (With Purdue Univ., Univ. Wis., and Univ. Calif.)

Morphological aspects of gymnosporangium galls. (Note.) By P. R. Miller. Phytopathology 26: 799–801.

A fungus on lace bugs [*Hirsutella verticilioides* sp. nov.] By V. K. Charles. Mycologia 29: 216–221.

Mimicry in *Hypoxylon*. By W. W. Diehl. Mycologia 29: 319.

Nitrogen utilization by *Ophiobolus graminis*. By H. Fellows. Jour. Agr. Research 53: 765–769.

A new species of *Phialea* on alder seeds. By J. R. Kienholz and E. K. Cash. Mycologia 29: 81–84.

"Spore mats" of *Phymatotrichum omnivorum*. (Note.) By J. T. Presley and C. Thom. Phytopathology 27: 588.

Two species of *Physalospora* in England. By N. E. Stevens. Mycologia 28: 330–336.

Pythium graminicolum and *P. arrhenomanes*. By C. Drechsler. Phytopathology 26: 676–684.

Echinulation of chamydospores and the pathogenicity of a previously undescribed physiologic race of *Sphacelotheca cruenta*. (Note.) By H. A. Rodenhiser. Phytopathology 27: 643–645.

NEMATODES

Notes on free-living and plant-parasitic nematodes, III. By G. Thorne. Helminthol. Soc. Wash. Proc. 4: 16–18.

A monograph of the nematode genera *Dorylaimus* Dujardin, *Aporcelaimus* n. g., *Dorylaimoides* n. g., and *Pungentus* n. g. By G. Thorne and H. H. Swanger. Capita Zoologica v. 6, pt. 4.

Anguillulina askenasyi (Bütschli, 1873), a gall forming nematode parasite of the common fern moss, *Thuidium delicatulum* (L.) Hedw. By G. Steiner. Jour. Wash. Acad. Sci. 26: 410–414.

Feeding habits of the nematodes *Aphelenchoides parietinus* and *Aphelenchus avenae*. By J. R. Christie and C. H. Arndt. Phytopathology 26: 698–701. (With S. C. Agr. Expt. Sta.)

Observations on a predaceous nematode. (*Aphelenchoides penardi*.) By C. W. McBeth. Helminthol. Soc. Wash. Proc. 4: 18.

A revision of the nematode family Cephalobidae Chitwood and Chitwood, 1934. By G. Thorne. Helminthol. Soc. Wash. Proc. 4: 1–16.

The genera and species of the Criconematinae, a subfamily of the Anguillulinidae (Nematoda). By A. L. Taylor. Amer. Micros. Soc. Trans. 55: 391–421.

Opuscula miscellanea nematologica, IV–V. By G. Steiner. Helminthol. Soc. Wash. Proc. 3: 74–80; 4: 33–38.

NUTS

Varieties of native nuts for the middle northern zone. By C. A. Reed. North. Nut Growers Assoc. Proc. 26: 71–77.

Root development of trees as affected by physical properties of the soils. By C. E. Schuster. Wash. State Hort. Assoc. Proc. 32: 22–26.

Root distribution in nut orchard soils. By C. E. Schuster. Oreg. State Hort. Soc. Proc. 28: 191–195.

Further notes on blossoming habits of the pecan and other species of nut trees in the Northeastern States. By C. A. Reed. North. Nut Growers Assoc. Proc. 26: 104–108.

Almond culture in California. By M. N. Wood. Calif. Agr. Ext. Serv. Cir. 103. (In cooperation.)

New filbert hybrids. By C. A. Reed. Jour. Heredity 27: 427–431.

Relation of shoot growth to setting and weight of fruit in the filbert. By C. E. Schuster. Amer. Soc. Hort. Sci. Proc. 34: 62–65.

Filberts in the Pacific Northwest. By C. E. Schuster. North. Nut Growers Assoc. Proc. 27: 124–129.

Current studies on the bacterial blight diseases of filberts and its control. By P. W. Miller. Oreg. State Hort. Soc. Proc. 28: 152–159.

Bunch disease of pecans. By J. R. Cole. Phytopathology 27: 604–612.

A disporous *Gnomonia* on pecan. By J. B. Demaree and J. R. Cole. Phytopathology 26: 1025–1029.

The use of ethylene to improve pecan harvesting. By A. H. Finch. Amer. Soc. Hort. Sci. Proc. 34: 74–77. (With Ariz. Agr. Expt. Sta.)

The influence of different pollens on the development of the pistache nut. By R. H. Peebles and C. Hope. Amer. Soc. Hort. Sci. Proc. 34: 29–32.

Natural walnut hybrids in the East. By C. A. Reed. North. Nut Growers Assoc. Proc. 27: 30–40.

Sixth report of progress on studies of walnut blight and its control in Oregon. By P. W. Miller. Oreg. State Hort. Soc. Proc. 28: 134–151.

ORNAMENTALS

A fertilization study on coniferous evergreens in the nursery. By P. C. Marth and F. E. Gardner. Amer. Soc. Hort. Sci. Proc. 34: 653–659.

The Christmas tree planting at Altadena, California. By A. D. Shamel. Natl. Hort. Mag. 16: 96–99.

Privet and jasmine galls produced by a species of *Phomopsis*. (Note.) By N. A. Brown. Phytopathology 26: 795–799.

Effect of amount of light on amaryllid flower color. By H. P. Traub. Herbertia [Yearbook Amer. Amaryllis Soc.] 3: 60.

Growth responses following stem cuttage of amaryllids. By H. P. Traub. Herbertia [Yearbook Amer. Amaryllis Soc.] 3: 115–117.

Bacterial leaf spot of begonia. By L. McCulloch. Jour. Agr. Research 54: 583–590.

A preliminary report on the respiration of Souvenir gladiolus corms before and after curing at various temperatures. By T. M. Whiteman. Amer. Soc. Hort. Sci. Proc. 34: 612–617.

Propagation of *Hemerocallis* (daylilies) by crown cuttage. By H. P. Traub. Herbertia [Yearbook Amer. Amaryllis Soc.] 3: 123–124.

Iris notes of 1936. By J. M. Shull. Bul. Amer. Iris Soc. 63: 46–55.

A mosaic disease of iris. By P. Brierley and F. P. McWhorter. Jour. Agr. Research 53: 621–635. (With Oreg. Agr. Expt. Sta.)

Easter lily breeding: Compatibilities in *Lilium longiflorum* stocks. By P. Brierley, S. L. Emsweller, and J. C. Miller. Amer. Soc. Hort. Sci. Proc. 34: 603–606.

Vegetative propagation of hybrid lily clons. By D. Griffiths. Roy. Hort. Soc. Lily Year-Book 4: 80–82.

Tulip species—Notes and pictures. By B. Y. Morrison. Natl. Hort. Mag. 15: 157–184.

Propagation of *Zephyranthes rosea* by under- and over-feeding. By H. P. Traub and A. E. Hughes. Herbertia [Yearbook Amer. Amaryllis Soc.] 3: 118–121.

PLANT PHYSIOLOGY

Recent work on photoperiodism. By W. W. Garner. Bot. Rev. 3: 259–275.

Selenium absorption by crop plants as related to their sulphur requirement. By A. M. Hurd-Karrer. Jour. Agr. Research 54: 601–608.

Selenium absorption by plants and their resulting toxicity to animals. By A. M. Hurd-Karrer. Smithsn. Inst. Ann. Rept. 1935: 289–301.

Toxicity of selenium-containing plants to aphids. By A. M. Hurd-Karrer and F. W. Poos. Science 84: 252. (With Bur. Ent. and Plant Quarantine.)

Sodium ethyl xanthate as a plant poison. By R. B. Harvey, J. Zalar, and R. H. Landon. Science 84: 356. (With Univ. Minn.)

SEEDS

Physiological problems involved in seed dormancy. By E. H. Toole. Internatl. Seed Testing Assoc. Proc. 8: 33–41.

Growing tests in an attempt to differentiate *Melilotus alba* and *Melilotus officinalis* on seed characteristics. By F. M. Torpy and E. F. Sirrine. Assoc. Off. Seed Anal. North Amer. Proc. 28: 58.

Coloring imported alfalfa and red clover seed as required under the Federal Seed Act. U. S. Bur. Plant Indus., Serv. & Regulat. Announc. (S. R. A.-B. P. I.) no. 22.

Persecutions and seizures under the interstate clause (sec. 6) of the Federal Seed Act. U. S. Bur. Plant Indus., Serv. & Regulat. Announc. (S. R. A.-B. P. I.) no. 23.

The interstate clause of the Federal Seed Act to date. By W. A. Davidson. Assoc. Off. Seed Anal. North Amer. Proc. 28: 54–57.

Inspection of agricultral seeds. By R. B. Schulte, H. R. Kraybill, and others. Ind. Agr. Expt. Sta. Cir. 225. (In cooperation.)

Report of the Committee on Handbook. By E. Brown. Assoc. Off. Seed Anal. North Amer. Proc. 28: 19.

Report of chairman of subcommittee on "Rules." By E. H. Toole. Assoc. Off. Seed Anal. North Amer. Proc. 28: 17–19.

SOIL FERTILITY

Report of the Committee on Soils. By O. Schreiner. Internatl. Soc. Sugar Cane Technol. Proc. 5: 604–608.

Lysimeter investigations. By N. McKaig, Jr., and E. M. Roller. S. C. Agr. Expt. Sta. Ann. Rept. 49: 115–119. (In cooperation.)

Formamide and ammonium formate as nitrogen sources for plants. By B. E. Brown and F. R. Reid. Soil Sci. 43: 341–346.

Melamine of possible plant food value. By W. Scholl, R. O. E. Davis, B. E. Brown, and F. R. Reid. Indus. and Engin. Chem. 29: 202–205. (With Bur. Chem. and Soils.)

The ammoniation of waste sulphite liquor and its possible utilization as a fertilizer material. By M. Phillips, M. J. Goss, B. E. Brown, and F. R. Reid. Jour. Agr. Research 53: 209–224. (With Bur. Chem. and Soils.)

SUGAR BEET

A genetic factor for the annual habit in beets and linkage relationship. By F. A. Abegg. Jour. Agr. Research 53: 493–511.

The influence of some climatological factors on seed-stalk development and seed yield of space-isolated mother beets. By H. L. Koh's. Jour. Amer. Soc. Agron. 29: 280–285.

Relation of nitrogen to yield of sugar-beet seed and to accompanying changes in composition of the roots. By L. M. Pultz. Jour. Agr. Research 54: 639–654.

The use of actual and competitive yield data from sugar beet experiments. By S. B. Nuckols. Jour. Amer. Soc. Agron. 28: 924–934.

Histological and cytological changes in sugar-beet seedlings affected with curly top. By E. Artschwager and R. C. Starrett. Jour. Agr. Research 53: 637–657.

Further studies on the relation of the curly top virus to plant tissues. By C. W. Bennett and K. Esau. Jour. Agr. Research 53: 595–620. (With Univ. Calif.)

Correlation between movement of the curly top virus and translocation of food in tobacco and sugar beet. By C. W. Bennett. Jour. Agr. Research 54: 479–502.

Land-improvement measures in relation to a possible control of the beet leaf-hopper and curly top. By R. L. Piemeisel and J. C. Chamberlin. U. S. Dept. Agr. Cir. 416. (With Bur. Ent. and Plant Quarantine.)

The pH gradient extending from the phloem into the parenchyma of the sugar beet and its relation to the feeding behavior of *Eutettix tenellus*. By J. M. Fife and V. L. Frampton. Jour. Agr. Research 53: 581–593.

Keeping quality of sugar beets as influenced by growth and nutritional factors. By F. G. Larmer. Jour. Agr. Research 54: 185–198.

SUGARCANE

Methods of selecting seedlings at the United States Sugar Plant Field Station, Canal Point, Fla. By G. B. Sartoris. Internatl. Soc. Sugar Cane Technol. Proc. 5: 328–333.

A study of sugar cane stalk age groups under Louisiana conditions. By G. Arceneaux. Internatl. Soc. Sugar Cane Technol. Proc. 5: 777–787.

Methods used by the Division of Soil Fertility Investigations to determine the fertilizer requirements of sugar cane in Louisiana. By A. M. O'Neal and L. A. Hurst. Internatl. Soc. Sugar Cane Technol. Proc. 5: 636–639.

Fertilizer studies on Yazoo and Lintonia soils, two important sugar-cane soils in Louisiana. By A. M. O'Neal, O. Schreiner, and L. A. Hurst. Internatl. Soc. Sugar Cane Technol. Proc. 5: 644–653.

Portable scale for use in weighing sugar cane on the soil fertility experiments in Louisiana. By A. M. O'Neal. Internatl. Soc. Sugar Cane Technol. Proc. 5: 796–798.

A brief review of some important contributions on soil and fertilizer investigations with sugar cane. By O. Schreiner and R. B. Deemer. Internatl. Soc. Sugar Cane Technol. Proc. 5: 654–663.

Publications relating to sugar-cane soil investigations (covering approximately 1931–1933). By O. Schreiner and R. B. Deemer. Internatl. Soc. Sugar Cane Technol. Proc. 5: 664–706.

Determining theoretical yields of sugar in connection with sugar cane variety tests on the basis of field sampling and laboratory-scale milling tests. By G. Arceneaux. Internatl. Soc. Sugar Cane Technol. Proc. 5: 568–578.

Special three-roller mill used in sugar-cane experimental field work. By O. Schreiner and N. McKaig, Jr. Internatl. Soc. Sugar Cane Technol. Proc. 5: 790–795.

Importance of the virus diseases of sugar cane. By E. W. Brandes and J. Matz. Internatl. Soc. Sugar Cane Technol. Proc. 5: 87–107.

Transmission of new types of sugar-cane mosaic and some observations on significance of the diseases. By E. W. Brandes. Internatl. Soc. Sugar Cane Technol. Proc. 5: 804–811.

Relative infectivity of mosaic virus in the different parts of infected sugar-cane. By J. Matz. Internatl. Soc. Sugar Cane Technol. Proc. 5: 799–803.

Strains of the sugar-cane mosaic virus in Louisiana. By E. M. Summers. Internatl. Soc. Sugar Cane Technol. Proc. 5: 723–729.

Physiologic specialization in *Colletotrichum falcatum* Went. By E. V. Abbott. Internatl. Soc. Sugar Cane Technol. Proc. 5: 730–736.

Apparent and true solids of sugarcane juice. By C. A. Fort and N. McKaig, Jr. Indus. and Engin. Chem., Analyt. Ed. 8: 333–335. (With Bur. Chem. and Soils.)

SYSTEMATIC BOTANY

Opportunities for studies of plant life in Virginia. By H. A. Allard. Claytonia 3: 1–3.

Notes by the way. [Virginia mountains.] By H. A. Allard. Claytonia 3: 40–42.

Botanical exploration of Loudoun County, Virginia. By O. M. Freeman. Claytonia 3: 54–55.

Ingenhouzia and *Thurberia*. By T. H. Kearney. Amer. Jour. Bot. 24: 298–300.

Anaphalis margaritacea in Virginia. (Note.) By H. A. Allard. Claytonia 1: 12.

New Asteraceae from Guatemala and Costa Rica collected by A. F. Skutch. By S. F. Blake. Brittonia 2: 329–361.

Four new plants of the genus *Diplostephium*. By S. F. Blake. Biol. Soc. Wash. Proc. 49: 77–82.

Eriogonum intrafractum, a new species and new subgenus from Death Valley, California. By F. V. Coville and C. V. Morton. Jour. Wash. Acad. Sci. 26: 303–306. (With U. S. Natl. Mus.)

Studies in the genus *Glonium* as represented in the Southeast. By M. L. Lohman. Bull. Torrey Bot. Club 64: 57–72.

A new *Helenium* from Virginia. By S. F. Blake. Claytonia 3: 13–15.

Lepidonia, a new genus of Vernonieae, with a nomenclatorial note on the name *Leiboldia*. By S. F. Blake. Jour. Wash. Acad. Sci. 26: 452–460.

Opuntia wrightiana (Baxter) comb. nov. By R. H. Peebles. Desert (Pasadena) 9: 43.

Phacelia covillei at Clarendon, Va. (Note.) By H. A. Allard. Claytonia 3: 28.

Phacelia mustelina, a new plant from Death Valley, California. By F. V. Coville. Jour. Wash. Acad. Sci. 7: 196–198.

A new plant of the genus *Polygala* from northern Mexico. By S. F. Blake. Biol. Soc. Wash. Proc. 49: 151–152.
Royal palms in upper Florida. By O. F. Cook. Science 84: 60–61.
Hurricane palms in Florida, including a new genus, *Simpsonia*. By O. F. Cook. Science 85: 332–333.
El tule—a plant immortal. By A. D. Shamel. Jour. Heredity 28: 35–38.
Tetracoccus ilicifolius, a new shrub from Death Valley, California. By F. V. Coville and M. F. Gilman. Jour. Wash. Acad. Sci. 26: 530–535. (With Natl. Park Serv., Dept. Interior.)

GRASSES

Poaceae. (Cont.) By A. S. Hitchcock. North Amer. Flora 17: 483–542.
Manual of the grasses of the West Indies. By A. S. Hitchcock. U. S. Dept. Agr. Misc. Pub. 243.
Notes on types of North American grasses. By A. Chase. Amer. Jour. Bot. 24: 33–35
Three new grasses from Indo-china. By J. R. Swallen. Jour. Wash. Acad. Sci. 26: 535–543.
Arthraxon hispidus var. *cryptatherus* (Hack.) Honda in Pennsylvania. By A. Chase. Rhodora 39: 100.
The grass genus *Mesosetum*. By J. R. Swallen. Brittonia 2: 363–392.
New species of *Paspalum* from tropical America. By A. Chase. Jour. Wash. Acad. Sci. 27: 143–146.

(See also Forage Crops, Grasses)

TOBACCO

The relation between genes affecting size and color in certain species of *Nicotiana*. By H. H. Smith. Genetics 22: 361–375.
Inheritance of corolla color in the cross *Nicotiana langsdorffii* by *N. sanderae*. By H. H. Smith. Genetics 22: 347–360.
Tobacco. By J. M. Carr and J. G. Gaines. Ga. Coastal Plains Expt. Sta. (Ann. Rept. 16) Bull. 26: 92–101. (In cooperation.)
Upper Coastal Plain Station—Rocky Mount N. C., Agronomy [Tobacco experiments] By R. E. Currin, Jr. N. C. Dept. Agr. Rept. 1934–36: 103–104. (In cooperation.)
Tobacco station—Oxford, N. C. By E. G. Moss. N. C. Dept. Agr. Rept. 1934–36: 83–92. (In cooperation.)
Tobacco investigations. By W. M. Lunn. S. C. Agr. Expt. Sta. Ann. Rept. 49: 93–98. (In cooperation.)
Recommendations for the fertilization of bright flue-cured tobacco. By H. P. Cooper, W. M. Lunn, and H. A. McGee. S. C. Agr. Expt. Sta. Ann. Rept. 49: 98–100. (In cooperation.)
Relation of root pressure to plant disease By J. Johnson. Science 84: 135–136.
Factors relating to the control of ordinary tobacco mosaic. By J. Johnson. Jour. Agr Research 54: 239–273. (With Univ. Wis.)
Flue-cured tobacco varieties. By E. G. Moss and J. F. Bullock. N. C. Dept. Agr. Bull. January 1937. (In cooperation.)

VEGETABLES

New varieties and strains of vegetables. By R. Magruder. Md. Agr. Soc. Rept. 20: 286–292. (Md. Veg. Growers' Assoc. Rept. 17.)
Vegetable variety tests at the Scottsbluff Substation. By L. Harris. Nebr. Agr. Expt. Sta. Bull. 300. (In cooperation.)
The Truck Experiment Station. By W. D. Moore. S. C. Agr. Expt. Sta. Ann Rept. 49: 126–130. (In cooperation.)
Magnesium deficiency. I. The value of magnesium compounds in vegetable production in Virginia. By R. L. Carolus and B. E. Brown. Va. Truck Expt. Sta. Bull. 89. (In cooperation.)
Frozen succotash. By J. S. Caldwell, J. M. Lutz, and H. H. Moon. Canning Age 17: 414–415, 434–435, 449–451, 472.

(See also general references under Fruit.)

BEAN

Histological reactions of bean plants to indoleacetic acid. By E. J. Kraus, N. A. Brown, and K. C. Hamner. Bot. Gaz. 98: 370–420.
Suitability of lima beans for freezing. Six bush and two pole varieties studied and reported. By J. S. Caldwell, J. M. Lutz, and H. H. Moon. Canning Age 17: 374–378, 393–395.
Lima beans in frozen pack. I. Blanching tests. II. Microbiological studies. By H. F. Smart and B. G. Brunstetter. Canner 83 (10): 14–16.
Effect of stage of maturity of the snap bean on its composition and use as a food product. By C. W. Culpepper. Food Research 1: 357–376.
Galls produced by plant hormones, including a hormone extracted from *Bacterium tumefaciens*. (Note.) By N. A. Brown and F. E. Gardner. Phytopathology 26: 708–713.
The relation of aphids to the transmission of bean mosaic. By W. J. Zaumeyer and C. W. Kearns. Phytopathology 26: 614–629.
Powdery mildew (*Erysiphe polygoni*) on garden snap beans. By W. D. Moore. Phytopathology 26: 1135–1144.
Rubber as a protective device on concave teeth for threshing seed beans. By B. L. Wade and W. J. Zaumeyer. Jour. Amer. Soc. Agron. 28: 723–726.

CABBAGE

A new color type in cabbage. By R. Magruder. Science 85: 427–428.

CELERY

Control of southern celery mosaic in Florida by removing weeds that serve as sources of mosaic infection. By F. L. Wellman. U. S. Dept. Agr. Tech. Bull. 548.

LETTUCE

The action of radiation of specific wavelengths in relation to the germination of light-sensitive lettuce seed. By L. H. Flint and E. D. McAlister. Internatl. Seed Testing Assoc. Proc. 8: 1–4. (With Smithsn. Inst.)
Wave lengths of radiation in the visible spectrum promoting the germination of light-sensitive lettuce seed. By L. H. Flint and E. D. McAlister. Smithsn. Misc. Collect., v. 96, no. 2. (With Smithsn. Inst.)

MUSKMELON

Development of Powdery Mildew Resistant Cantaloup No. 45. By I. C. Jagger and G. W. Scott. U. S. Dept. Agr. Cir. 441. (With Calif. Agr. Expt. Sta.)

ONION

A male-sterile onion. By H. A. Jones and S. L. Emsweller. Amer. Soc. Hort. Sci. Proc. 34: 582–585.
Bulb formation in some American and European varieties of onions as affected by length of day. By R. Magruder and H. A. Allard. Jour. Agr. Research 54: 719–752.

PEA

A new maturity test of peas. By S. L. Jodidi. Jour. Franklin Inst. 223: 593–607.

Pea mosaic and its relation to other legume mosaic viruses. By W. J. Zaumeyer and B. L. Wade. Jour. Agr. Research 53: 161–185.

Peas for freezing; A study of suitability for freezing purposes in eighteen varieties of peas grown under eastern conditions. By H. H. Moon, J. S. Caldwell, and J. M. Lutz. Canner 83 (4): 7–8, 11–14; (5): 13–16.

PEANUT

Plot and plant variation in Virginia peanuts. By J. H. Beattie, V. R. Boswell, and E. T. Batten. Amer. Soc. Hort. Sci. Proc. 34: 586–589. (With Va. Agr. Expt. Sub Sta., Holland, Va.)

POTATO

The Houma potato: A new variety. By C. F. Clark, F. J. Stevenson, and J. C. Miller. U. S. Dept. Agr. Cir. 420. (With La. Agr. Expt. Sta.)

A discussion of potato sprout emergence as related to fertilizer placement. By G. V. C. Houghland. Amer. Potato Jour. 13: 343–346.

Fertilizer placement for potatoes. By B. E. Brown and G. A. Cumings. Amer. Potato Jour. 13: 269–272. (With Bur. Agr. Engin.)

Irish potato fertilizer experiments. By H. P. Cooper, W. D. Moore, and R. W. Wallace. S. C. Agr. Expt. Sta. Cir. 55. (In cooperation.)

Some changes in potato fertilizer use. By B. E. Brown. Amer. Potato Jour. 13: 327–339.

Comparative influence of different tillage practices on the yield of the Katahdin potato in Maine. By P. M. Lombard. Amer. Potato Jour. 13: 252–255.

An abnormal graft reaction in potato resulting from a virus infection of a scion on a resistant stock. (Note.) By W. P. Raleigh. Phytopathology 26: 795.

Recent developments in potato breeding for resistance to virus diseases. By E. S. Schultz, C. F. Clark, W. P. Raleigh, F. J. Stevenson, R. Bonde, and J. H. Beaumont. Phytopathology 27: 190–197. (With Maine and Md. Agr. Expt. Stas.)

Resistance of the potato to latent mosaic. By E. S. Schultz, C. F. Clark, F. J. Stevenson, and W. P. Raleigh. Amer. Potato Jour. 14: 124–127.

Breeding for resistance to late blight in the potato. By F. J. Stevenson, E. S. Schultz, C. F. Clark, W. P. Raleigh, L. C. Cash and R. Bonde. Amer. Potato Jour. 13: 205–218. (With Maine Agr. Expt. Sta.)

Breeding for resistance to common scab in the potato. By C. F. Clark, W. P. Raleigh and F. J. Stevenson. Amer. Potato Jour. 13: 256–259.

A study of scab resistance in the potato. By H. M. Darling. Jour. Agr. Research 54: 305–317. (With Minn. Agr. Expt. Sta.)

Reclamation of potato land flooded by salt water. By G. V. C. Houghland. Amer. Potato Jour. 14: 19–22.

SPINACH

The effect of controlled photoperiod on the production of seed stalks in eight varieties of spinach. By R. Magruder and H. A. Allard. Amer. Soc. Hort. Sci. Proc. 34: 502–506.

SWEET CORN

Corn for freezing. A study of comparative suitability for freezing preservation in 35 varieties and strains of sweet corn grown under eastern conditions. By J. S. Caldwell, J. M. Lutz, and C. W. Culpepper. Canner 83 (6): 11–13, 20; (7): 11–14, 16, 32; (8): 15–16; (9): 13–14, 28.

SWEETPOTATO

Grade and shape of sweetpotatoes in response to potash in South Carolina. By V. R. Boswell and J. H. Beattie. Amer. Soc. Hort. Sci. Proc. 34: 451–455.

TOMATO

Histological and microchemical studies of the reactions of tomato plants to indoleacetic acid. By H. A. Borthwick, K. C. Hamner, and M. W. Parker. Bot. Gaz. 98: 491–519.

The influence of soil moisture and fertilizers on the specific electrical conductivity of tomato plant sap. By A. C. Foster and E. C. Tatman. Amer. Jour. Bot. 24: 35–39.

Development of disease resistant varieties of tomatoes. By W. S. Porte. Md. Agr. Soc. Rept. 20: 264–269. (Md. Veg. Growers' Assoc. Rpt. 17.)

Un virus infectant des Solanées et des plantes d'ornement dans le sud-ouest de la France. By M. Shapovalov and J. Dufrenoy. Compt. Rend. Soc. Biol. [Paris] 123: 696–698. (With Sta. Path. Veg. Sud-ouest, Bordeaux, France.)

The Riverside tomato. A new variety resistant to two wilt diseases. By J. W. Lesley and M. Shapovalov. Seed World 41 (7): 8–9. (With Univ. Calif. Citrus Expt. Sta.)

Temperature studies of some tomato pathogens. By A. A. Nightingale and G. B. Ramsey. U. S. Dept. Agr. Tech. Bull. 520.

Curly top or western yellow blight of tomato. By B. F. Dana. Oreg. State Hort. Soc. Proc. 28: 72–74.

Injury to greenhouse tomatoes as a result of a combined infection with the viruses causing tomato and cucumber mosaic. (Note.) By S. P. Doolittle and L. J. Alexander. Phytopathology 26: 920–923. (With Ohio Agr. Expt. Sta.)

WESTERN IRRIGATION AGRICULTURE

The choice of crops for saline land. By T. H. Kearney and C. S. Scofield. U. S. Dept. Agr. Cir. 404.

Practical crop rotations for irrigation potato farmers. By L. Harris. Nebr. State Bd. Agr. Ann. Rept. 1936: 703–707.

Automatically operated sand-culture equipment. By F. M. Eaton. Jour. Agr. Research 53: 433–444.

Subsoil waters of Newlands (Nev.) Field Station. By C. S. Scofield, C. L. Moon, and E. W. Knight. U. S. Dept. Agr. Tech. Bull. 533.

MISCELLANEOUS

Report of the Chief of the Bureau of Plant Industry [for the fiscal year ended June 30], 1936. By F. D. Richey.

Directory of activities of the Bureau of Plant Industry. U. S. Dept. Agr. Misc. Pub. 238.

Plant material introduced by the Division of Plant Exploration and Introduction, Bureau of Plant Industry, April 1 to June 30, 1934. (Nos. 105036–105932.) U. S. Dept. Agr. Inventory 119.

The place of iarovization in plant breeding. By A. J. Bruman. Jour. Heredity 28: 31–33.

Rubber production from *Castilla* and *Hevea*. By O. F. Cook. Science 85: 406–407.

Progress in plant pathology: Control of disease by resistant varieties. By G. H. Coons. Phytopathology 27: 622–632.

The collection of micro-organisms above 36,000 feet. By L. A. Rogers and F. C. Meier. Natl. Geogr. Soc. Contributed Tech. Papers Stratosphere Ser. 2: 146–151. (With Bur. Dairy Indus.)

The relation of *Bacillus siamensis* and similar pathogenic spore-forming bacteria to *Bacillus cereus*. By F. E. Clark. Jour. Bact. 33: 435–443.

Trichomes of incidental importance as centers for local virus infections. By L. W. Boyle and H. H. McKinney. Science 85: 458–459.

Virus mutation and the gene concept. By H. H. McKinney. Jour. Heredity 28: 51–57.

Report on total chlorine in plants. By H. L. Wilkins. Jour. Assoc. Off. Agr. Chem. 19: 366–371.

Determination of potassium by means of an aqueous solution of trisodium cobaltinitrite in the presence of nitric acid. By L. V. Wilcox. Indus. and Engin. Chem. 29: 136–138.

Soluble starch: A study of its properties with a recommended supplementary procedure for determining its suitability for use in the Lintner determination. By S. R. Snider and D. A. Coleman. Cereal Chem. 14: 1–17. (With Bur. Agr. Econ.)

A humidity- and temperature-control cabinet for growing plants. By C. O. Grandfield and F. J. Zink. Jour. Agr. Research 54: 503–508. (With Kans. Agr. Expt. Sta.)

Index board for labeling photographs. By G. W. Burton. Jour. Amer. Soc. Agron. 29: 420–421.

Metal slide mounts for microscopic objects. By W. D. Courtney. Helminthol. Soc. Wash. Proc. 3: 72–74.

A simple device for recording the time and duration of rainfall. By R. R. Hirt. Phytopathology 26: 1064–1067. (With N. Y. State Col. Forestry.)

A simple micro- and macro-Kjeldahl steam distillation apparatus. By J. M. Fife. Indus. and Engin. Chem., Analyt. Ed. 8: 316.

New Jamaican and Cuban millipeds, with notes on several other species. By H. F. Loomis. Bull. Mus. Compar. Zool. 80: 215–228.

Crested millipeds of the family Lysiopetalidae in North America, with descriptions of new genera and species. By H. F. Loomis. U. S. Natl. Mus. Proc. 84: 97–135.

New millipeds of the American family Striariidae. By H. F. Loomis. Jour. Wash. Acad. Sci. 26: 404–409.

Research and social welfare. By A. F. Woods. Minn. Agr. Expt. Sta. Bull. 328: 49–51.

Chinese famine herbals and Nashi pictographic manuscripts. By W. T. Swingle. U. S. Libr. Cong. Rept. Librarian 1935–36: 184–195.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D.C. - - - - - - Price 10 cents

REPORT OF THE ADMINISTRATOR OF THE RESETTLEMENT ADMINISTRATION, 1937

United States Department of Agriculture,
Resettlement Administration,
Washington, D. C., October 1, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I transmit herewith a report of the work of the Resettlement Administration for the fiscal year ended June 30, 1937.

Sincerely yours,

Will W. Alexander,
Administrator.

CONTENTS

INTRODUCTION

On July 1, 1937, the Resettlement Administration completed its second full year of work. In general its program continued along the four major lines established during the first year of the agency's existence. These were:

Rural rehabilitation: The extension of supervised credit to farm families unable to secure credit elsewhere, for the purpose of purchasing needed stock, equipment, and sometimes for the renting of land in order to enable them to become self supporting.

Land utilization: The development of basic land-use plans for the important problem areas in American agriculture and the purchase of more than 9,000,000 acres of land unsuited to farming as one means of accomplishing necessary adjustments in land use for the purpose of agricultural rehabilitation.

Rural resettlement: The development of farms and part-time farms on good land for farm families that have lacked the necessary fertile land for successful operations.

Suburban resettlement: The development of three green-belt towns, near large cities and industrial centers, as demonstrations of a new and highly improved technique of land use and town planning in suburban areas.

Although the program of the Resettlement Administration as a whole remained unchanged in its basic character and purposes, the experience gained during the first year of its work made possible improvements in policy and practice that helped achieve a more effective and economical operation.

22592—37——1

The development of a more closely knit program has been a feature of the year's work. There exists a close interrelationship among the various aspects of this program to rehabilitate the poorer and more handicapped elements of the farm population. Basically, the cause of the depressed condition of this element of American agriculture may be traced to faulty relationships to the land. It is often expressed by such diverse manifestations as excessive debt, ignorance, poor land, and faulty systems of land tenure. Study and work on these problems during the year has stressed the need for a concerted attack on the problem of agricultural rehabilitation from several angles.

Practical experience gained in field operations have made possible a closer coordination of the three major agricultural programs. Rural-rehabilitation activities have been brought into a more positive relationship to resettlement problems, and vice versa. As land-use planning work has progressed, its findings have been made available for the guidance of rural-rehabilitation work, and have also been of great value to the development of rural resettlement plans. In general, this closer integration of action programs with planning activities has resulted in the establishment of a firmer foundation for long-range activities on the part of the Resettlement Administration as a whole.

In this connection, this agency made important contributions during the past year to the study of certain national problems of agricultural rehabilitation. One of these was the program to create a more stable economy in the great Plains region. Various units of the Administration, particularly the Land Utilization Division, rendered assistance to the President's Great Plains committee in the formulation of policies for the economic reconstruction of that vast problem area.

The need for a coordinated attack on the problem of farm insecurity was also stressed by the President's special committee on farm tenancy. After its study of Nation-wide conditions affecting farm tenancy and allied problems, this committee, on which several members of the Administration served, and for which others did considerable work, outlined to the President a threefold program of improved farm tenure, rural rehabilitation, and better land utilization, the larger part of which was written into the Bankhead-Jones Farm Tenant Act of 1937 by the Congress.

Changes in policy have been reflected in administrative improvements in the program. Certain simplifications of the internal structure of the organization have been carried out, and changes in the character of projects have also been found desirable. Greater emphasis has been laid upon the development of resettlement projects of the infiltration type or individual farms as opposed to the development of rural communities. It was found advisable to reduce the costs of farm units developed by this agency, and in April, new and lower limitations upon the average cost of farm buildings and other improvements were agreed upon. At the same time it was decided that work for the remainder of the year would be concentrated on the completion of projects already under way. No new projects were developed from this time.

The widespread damage to farm property by drought and flood during the past year made it necessary for the Administration to throw much of its energies in the rehabilitation of farmers in the stricken areas.

In the drouth area of 1936, two major types of assistance were rendered by this agency. Emergency loans were made available to farmers whose crops had been destroyed by drouth, and the problem of direct relief was met by the granting of small sums to families who faced destitution unless some outside help were given. In addition, an information service was set up whereby farmers who decided to migrate out of the Great Plains region were helped to find localities in other States where opportunities for farm settlement existed. The settlement of a large number of emigrants from the Great Plains on areas of poor land in States where they were not familiar with land conditions, emphasized the need for some guidance of this nature.

Following closely upon the heels of the drouth, the great flood of the Ohio and Mississippi Rivers in the early part of 1937 wrought additional damage. During the tense hours when the rivers were rising throughout the Ohio Valley, the equipment and work crews of the Administration's projects were made available to assist the Army engineers and the Works Progress Administration in building emergency levees and otherwise helping to diminish the possibilities of flood damage. Similar service was rendered during the reconstruction period.

Although the flood did not directly injure as many farmers as did the drouth, relatively large areas along the river valleys were seriously damaged and crops

destroyed. Through the rehabilitation program, farmers have been helped to recoup their losses both with emergency relief and with technical advice on how to salvage damaged crops and improvements with the least possible loss.

Both drouth and flood served as subject matter for two documentary motion pictures which have been produced for the purpose of portraying basic problems of land use and agricultural rehabilitation. During the past year "The Plow That Broke the Plains", the first of these two documentary films, which was prepared by the Resettlement Administration, was distributed to approximately 3,000 commercial motion-picture houses throughout the United States and was seen by an estimated audience of about 10,000,000 people. At the same time work was initiated on a second documentary film which has as its central theme the Mississippi River. This film is intended for release during the fall of 1937.

The high praise with which "The Plow That Broke the Plains" was received, indicates the important educational value inherent in the documentary moving picture as a means of building up an intelligent public understanding of problems concerning our land resources.

RURAL REHABILITATION

Aiding destitute and low-income farm families through a system of supervised credit forms the basic element of the rehabilitation program. Other associated activities in this field include farm-debt adjustment, the extension of group loans to farmers, and the relief of victims of drouth, flood, and other disasters.

SUPERVISED CREDIT

Supervised credit is based upon the realization that farm families in the less advantaged groups cannot improve their condition without a combination of financial help and technical guidance. On the one hand they are unable to take advantage of the available educational and scientific facilities of the Department of Agriculture because they lack the necessary financial resources to introduce improvements in their farm operations. On the other hand, they cannot qualify for financial help offered by other established agencies because they are unable, without better training, to improve their farming to the point where they might build up an equity that would serve as the basis of a loan. The rural-rehabilitation program of supervised and financed home and farm management has been formulated to break this dilemma, by bringing both credit and technical guidance to the aid of the disadvantaged farmer.

Clients of this program are helped to formulate a farm and home plan for the most economical use of their land, labor, livestock, and crops. These plans are financed by small short-term loans of 2 to 5 years. The loans cover the cost of the minimum of livestock, equipment, operating supplies, and subsistence required by the family to make a living in keeping with acceptable standards and local conditions, and to pay operating expenses and repay the rehabilitation loan.

Since the inception of the program, standard rehabilitation loans based on farm- and home-management plans have been made to more than 300,000 low-income farm families. These loans, including standard, supplemental, and emergency advances, totaled approximately $150,000,000. During the year standard loans were made in the amount of approximately $53,000,000. Not all low-income farm families eligible for such loans could be accommodated during the loaning season.

INFLUENCE OF COUNTY REHABILITATION SUPERVISORS

County and home rural-rehabilitation supervisors have been remarkably effective in gaining the confidence and cooperation of rural-rehabilitation clients. Liens on the clients' chattels and crops are required as security for rehabilitation loans, and the existence of such liens has protected clients from other less-favorable creditors. Nevertheless, the cooperation between clients and county and home supervisors in working out farm and home plans, and the supervision given by these representatives have constituted the best security for funds advanced to these clients. Although not generally recognized as such, this supervision has constituted a most effective method of rural vocational training, in addition to securing effective repayment of the loans. Farm- and home-plan financing is on a 2- to 5-year maturity basis; yet clients

repaid during the fiscal year approximately $24,000,000 consisting of maturities on previous years' loans as well as on loans not yet due.

BROAD RESULTS OF STANDARD FARM AND HOME PLAN PROGRAM

Farm- and home-management plans have made possible a great increase in the financial net worth of groups of clients in areas where drought or other catastrophes have not interfered. In Alabama, the average net worth of clients was increased from $3 to $362 during 1935–36. The total net worth of approximately 13,000 Alabama clients in 1935 was $40,000. In 1937, it was over $4,000,000.

Higher standards of living have also resulted from this program since clients have been required to produce and conserve sufficient meats, vegetables, milk, and poultry products necessary for the year round. Arkansas this year reports 58 quarts of canned products, 39 pounds of dried products, 4 bushels of potatoes, and 10 pints of other foodstuffs preserved for each member of 8,570 rehabilitation families in the State.

In many areas the children of these families have been encouraged to attend a complete term of school for the first time. Likewise, the self-respect of clients' families has risen to the point that many are again participating in community activities from which their insecurity had forced them to withdraw.

Winter cover crops, higher yielding seed strains, and soil conservation and erosion control practices have been generally introduced into clients' farming operations. There has been a general increase in the use of purebred sires and an increased interest in raising work stock for small farm use through the introduction of high-quality jacks and stallions. In Washington County, Colo., there was an increase of 50 to 100 percent in the number of livestock units per farm. The modification of farm practices under the rehabilitation program has provided for a general increase in the forage and feed crops produced for consumption on the farm. It has been particularly gratifying to note the increase in the number of meat animals, milk cows, and poultry kept for home consumption. Seventy-nine percent of clients in Alabama are keeping milk cows as against 47 percent in 1935. Generally there has come about a measurable quickening of interest in improved farm-management and improved land-use practices.

GROUP LOANS

Much of the equipment used on farms, as well as high-priced breeding animals, is too expensive for individual families to purchase under a sound farm and home plan. To meet this situation group loans have been made to enable low-income farmers and rural-rehabilitation clients to purchase purebred sires, the more expensive farm machinery such as grinding and processing mills, terracing outfits, harvesting machinery, and home equipment for canning, laundering, and butchering, upon a cooperative basis. Clients and low-income farm families have similarly been financed in establishing veterinary associations, health and dental associations, seed-improvement associations, pest-control associations, equipment-center associations, and fruit- and vegetable-purchasing associations in order to serve their group need at a small individual expense.

During the period July 1, 1935 to June 30, 1937, 2,450 of these group service plans were approved involving loans to individuals amounting to almost $1,200,000 for participation in and use of such services. The average amount required for the establishment of one of these group services was $488.93, each participant being advanced an average of $23.44. More than 51,000 rural farm families are now participating in such group service associations. This aspect of the program has stimulated the improvement of farm practices among low-income families through the wider use of purebred sires and high-quality seed, and the adoption of soil conservation and erosion control measures and generally more effective farm- and home-management practices.

NEED FOR SUPPLEMENTAL PROGRAM

Field experience in investigating applicants for standard rehabilitation aid and in supervising clients' families in their farm and home operations, has confirmed the fundamental soundness of the program of supervised and financed home and farm management. This experience has also indicated, however, that about only half of the destitute and low-income farm families are immediately capable of achieving a self-supporting status through the financed and

supervised farm and home plan process. It has revealed a need for an auxiliary program which can be applied to the lower half of this group, comprised principally of sharecroppers and day laborers who are not ready to undertake the responsibility of operating an independent farm unit.

A different type of loan plan would be required for this group of rural families. A small amount of money would be made available to finance subsistence farming for farm laborers and other rural workers. This type of case would be distinguished from the standard rural-rehabilitation case in that the source of cash income would be from work on farms, public works, or local industry rather than from cash crops or cash livestock products.

FARM DEBT ADJUSTMENT

Farm debt adjustment activities were conducted with the advice and assistance of 41 State farm debt adjustment committees, and 2,908 county farm debt adjustment committees comprising a total of 12,646 volunteer members appointed by the governors of the States. Committeemen were selected on the basis of their standing in their community and their reputation for fair dealing and good judgment.

During the year, 27,011 individual cases were satisfactorily adjusted. Debts totalling $96,233,056 were reduced to $70,879,288, a decrease of 26 percent. As a result of these adjustments which placed farmers in a sounder economic position, $1,724,674 in delinquent taxes were paid to local governments. 19,797 loans for the refinancing of these adjusted debts were arranged through Federal land banks, production credit associations, insurance companies, local banks, private lenders, and the Resettlement Administration.

Thirteen group cases in farm debt adjustment involving irrigation or drainage districts were completed which directly affected 2,723 farms. The indebtedness in these cases, which before adjustment amounted to $2,770,355, was reduced to $1,160,246.

EMERGENCY PROGRAM

The emergency rural-rehabilitation program was put into effect on July 14, 1936, and was carried on in 25 States in which emergency drouth counties were designated during that summer by the Department of Agriculture. It was the responsibility of the Administration to provide destitute farm families in these areas with human subsistence; to work out methods of overcoming the shortage of livestock feed; and to finance farming operations during the fall of 1936 and to some extent in the spring of 1937. By midwinter of 1936–37, the Administration was making grants for human subsistence to over 400,000 rural families in the drouth area. The total amount of these subsistence grants to drouth-stricken rural families as a result of the 1936 drouth was $22,663,406.53. An additional $12,000,000 was spent for subsistence grants to destitute farm families in States outside the drouth area, about half of this going to drouth refugees who emigrated to other areas.

The problem of how to maintain livestock in the face of the feed shortage was extremely serious. The rural-rehabilitation program provided emergency loans to feed the livestock on drouth-stricken farms that were necessary for the subsistence of the family; and to feed work stock that were needed for farming operations. Likewise, emergency feed loans were provided to sustain foundation herds of range cattle and dairy cattle and foundation flocks of sheep, whether purebred or high grade. Through a feed-purchase service, information was supplied through county supervisors on the price and location of forage within the drouth areas. In addition, livestock feed was purchased and brought into the drouth sections where it was not readily available at reasonable prices.

Where the indebtedness of farmers in the drought area was such that they could not qualify for credit from other agencies such as the production credit associations, or the emergency crop and feed loan section of the Farm Credit Administration, the rural-rehabilitation program provided emergency crop loans. Such loans were made only when there appeared to be a reasonable expectation of a crop that would justify the outlay for the season's labor. The total amount of these emergency loans to 75,000 farmers for feed and crop purposes amounted to over $17,000,000.

A series of pamphlets prepared by the land-use planning section of the Administration and giving information about farming conditions in States to which drought refugees were migrating in greatest numbers, was distributed to rural-

rehabilitation supervisors. This information made it possible for the field representatives to advise intelligently those farmers who had determined to leave the drought area for other parts. It was hoped that this service would discourage wholesale aimless migration from drought areas to localities where no opportunity for additional farm settlement existed.

Loans totaling $435,123 for the purpose of financing farm operations were made to 214 farm families which emigrated from the drought area to California, Idaho, Oregon, Texas, and Washington. These same families received subsistence grants amounting to $15,490.50.

NUMBER OF CLIENTS TO DATE

The total number of actively serviced rural-rehabilitation clients having standard and emergency loans as of the end of the fiscal year was approximately 488,000. During a 3-year period more than 4,500,000 persons, or approximately 1,000,000 farm families, have availed themselves of rural rehabilitation assistance administered by the Resettlement Administration and its predecessors, the State rural-rehabilitation corporations.

TENURE IMPROVEMENTS

Special emphasis has been laid upon the development of better conditions among farm tenants through the operation of the rural-rehabilitation program. Approximately 75 percent of the rehabilitation clients are tenants, including a large number of farmers who have been enabled to climb from the position of sharecropper or farm laborer to that of tenant as a result of rehabilitation loans.

Although certain difficulties are encountered, genuine progress has been made in improving the leasing arrangements of farm tenants in the rehabilitation program. Terms of leases have in many cases been extended from 1 year to 2 and 3 years. Increasing use has been made of written leases, and in some areas where verbal agreements between landlord and tenant have been usual, written leases have been made obligatory between landlords and rehabilitation clients. Provision for compensation of tenants for unexhausted improvements have also been introduced into leases to some extent.

HEALTH SERVICES

Health has long been a serious problem to many families served by the rehabilitation program. From the beginning, they have shown unusual eagerness to improve their sanitary conditions and oportunities for obtaining adequate medical and dental services. In a number of localities group medical associations have been formed with the aid of Resettlement officials, and often with the active assistance of county and State medical societies. In this way, low-income farm families have assured themselves of competent medical and dental attention at a minimum cost, and at the same time have provided a system of prompt and satisfactory compensation for such services. This work has been closely related to such activities as improving sanitary facilities and teaching farm families to raise and preserve foods that will constitute a healthful diet.

LAND UTILIZATION

The land-utilization program is presented here in two parts. The first summarizes the land-use planning activities, while the second describes the work in regard to what are generally known as the submarginal land projects.

LAND-USE PLANNING

The basic aim of land-use planning is to formulate policies and programs that will achieve a balanced relationship between rural people and their land resources. Two general methods are available for promoting the objectives of land-use planning. One leans to public ownership, administration, and control by the Federal Government. The other demands voluntary corrective and preventive actions by the people themselves, utilizing the regulatory powers of State and local governments. This procedure relies heavily upon the democratic process. The land-use planning program of the Resettlement Administration makes use of both of these methods.

Organization of the program is along four major lines: (1) Land classification, (2) water-utilization policies in relation to land use, (3) land policies, including analysis of institutional arrangements, such as land tenure or tax systems, and (4) land programs, for putting into effect the institutional changes which are needed to bring about desirable adjustments.

LAND CLASSIFICATION

Land classification during the year has been of two general types: The first has consisted of outlining problem areas (1) in which many of the farms are on land unsuited to farming and (2) in which many of the farms are too small to provide adequate family living without depleting the soil. This work has been used as a guide for the submarginal-land-purchase program, and other related activities.

The second type of land classification has consisted of a more intensive analysis of land classes in special areas of rural poverty, and in areas where there has been new farm settlement of considerable proportions. This classification has indicated land districts that are primarily suited to farming, forestry, or some other major use, and has in some cases pointed out the type of farming to which each district appears suited. This type of classification, with slight variations in some cases, has been carried on in about 100 counties during the year.

An attempt has also been made to identify the general areas in each State offering superior opportunities for the creation of new farms. This investigation has been carried as far as it can by a reconnaissance procedure.

Water-utilization economists have done considerable service work for various programs of the Administration, determining the adequacy of the water supply, and economic desirability of developments that depend upon continued water supply in combination with land. Water-utilization data of a similar nature have been furnished to numerous other agencies, and a member of the staff served as liaison officer on the water resources committee of the National Resources Committee and on the Flood Control Coordinating Committee.

Other activities in the field of water utilization have been centered mostly around studies of ground-water supply and utilization, particularly in the southern High Plains. Investigations of surface-water supply have also been made over entire watersheds, and considerable work has been done in analyzing legislation, court decisions, and procedure concerning water rights in the western States. Some studies have been made to determine necessary adjustments for distressed irrigation areas.

PUBLIC FINANCE IN RELATION TO LAND USE

The general work in public finance is concerned with the effects upon land use of the present structure of State and local governments and of methods of financing their activities. These studies have embraced such subjects as differential or classified property taxes, homestead exemptions, property-tax-limitation laws, and tax-collection and tax-delinquency procedure in their effect upon land use. Problems have been investigated in sample counties, and on a State-wide basis.

The bulk of the public finance work, however, has been concerned with operating programs of the Administration. Agreements as authorized by Congress, have been drawn up between the Resettlement Administration and State, county, and local governmental units providing for payments in lieu of taxes upon lands and improvements owned by the United States in project areas. Detailed analyses of the fiscal consequences of about 45 of the larger of submarginal-land-purchase projects have been made, and tentative plans for governmental reorganization in the project areas have been drawn up.

STUDIES OF RURAL LAND SETTLEMENT

A comprehensive survey has been made of the areas throughout the United States in which recent land settlement has been substantial to determine the extent of settlement, the kind of land settled, the types of farming followed, the success or failure of the recent settlers, and land-use problems created by these movements.

Nonfarm incomes of farm people are now being studied, involving an analysis of the possibilities of combining farming with industrial employment,

work in forests and forest industries, and other nonfarm activities. The land-use-planning staff also assembled material concerning opportunities for individual private farm settlement in several States to which farmers from the drought area have migrated in the largest numbers. This information was turned over to field representatives of the Administration to help them advise migrating farmers as to where they might find the best opportunities for building up new farms.

LAND TENURE AND FARM TENANCY

A comprehensive survey of the development and characteristics of American farm tenancy has been completed this year. The results of this work have been made available in the form of several publications, which include reports on compensation as a means of improving farm tenancy, on the land-tenure-reform programs of several foreign countries, and the landlord-tenant laws in Iowa. Three detailed field studies have been made in cooperation with other agencies, of the relationships between land tenure and land-use maladjustments, particularly soil erosion.

With the assistance of the Bureau of Agricultural Economics and other agencies, the Land Use Planning Section assembled the technical materials for the report of the President's Special Committee on Farm Tenancy, published early in 1936, and prepared the first draft of the technical supplement to this report.

DIRECTIONAL MEASURES FOR LAND-USE ADJUSTMENTS

Various measures such as rural-zoning ordinances, erosion-control and other police-power regulations, modifications in credit policies, formation of cooperative grazing districts, the purchase of easements, and the use of covenants in the sale of land must be employed in addition to land purchase if necessary improvements in land use are to be effected. The Land Use Planning Section has investigated the possibilities, limitations, and practicability of these land-use directional measures, and to work out recommendations for their use, adapted to the varying conditions encountered in different parts of the United States.

Publications were issued dealing with the constitutionality of rural zoning and with problems of drafting rural-zoning enabling legislation by State legislatures. Assistance was given to organizations in several States interested in working out local zoning programs. Methods of grazing regulation under State law were studied in Arkansas, Montana, Wyoming, and Colorado. An analysis of the controlled use of credit as a directional measure for better land use has been started, and steps have also been taken to help guide the rural-rehabilitation program along the lines of such policy.

AREA PLANNING STUDIES

In many of the areas, the important land-use maladjustments are so closely interrelated that any successful rehabilitation requires concurrent action along several different lines. Likewise, in order to study the situation effectively, and develop adequate recommendations for action, a comprehensive investigation of the area must be made, involving the entire complex of population and natural resources. The techniques of land classification, water utilization, land settlement, and public-finance investigations must be brought into use.

Studies such as these have been under way in about 40 areas in various parts of the United States, each embracing from 1 to 50 counties. Preliminary reports of some of the studies have been submitted, and one report, covering Fergus County, Mont., has been published.

ANALYSIS OF LEGISLATION AFFECTING LAND USE

Recommendations for legislation on land and water use can be made realistically only after an investigation has been made of the constitutional, statutory, and administrative governmental organizations in the jurisdictions concerned. The appraisal of legislative proposals regarding land use, from the standpoint of their relationships to the existing legislative structure and procedure, is the primary function of the legislative analysis carried on by the land-use planning staff and distinguishes it from the common type of legal research.

EDUCATIONAL ACTIVITIES IN LAND-USE PLANNING

It is of primary importance that the implications of land-use problems and proposed adjustment measures are thoroughly understood by the people directly affected, and that local groups and individuals take active part in the formulation and effectuation of land-use policies. Field workers in land-use planning have therefore incorporated educational activities in their regular work, making frequent addresses at meetings of farm people, delivering radio addresses, and writing articles for the rural press, etc.

To facilitate an interchange of ideas and information among the technicians on the objectives and procedures of land-use planning, the Land Policy Circular is published monthly by the Land Use Planning Section in cooperation with the Bureau of Agricultural Economics. In addition, 18 titles in the land-use planning publication series have been issued, reference to various of these technical reports having been made elsewhere.

SPECIAL AID TO OTHER AGENCIES

The land-use planning work has been of service to numerous agencies of both Federal and State Governments, and various mention of special help rendered have already been made above. Following the appointment of the Great Plains committee in the fall of 1936, the Land Use Planning Section contributed the first draft of the bulk of the main body of the committee's report, and a number of memoranda which were used in the appendix. The report of the Great Plains Committee, published in January 1937, amplified the recommendations of the earlier Great Plains drought area committee, made to the President in August 1936, which was reviewed in the Report of the Secretary for 1936.

At the request of the Rural Electrification Administration, special reports have been made by the State land-use planning specialists in 116 counties in 27 States to aid in the economic planning of the rural-electrification program, particularly in recognized land-problem areas.

COORDINATION OF LAND-USE PLANNING ACTIVITIES

The extensive program of land-use planning activities being carried on by the regional and Washington land-use planning sections requires guidance, leadership, and coordination if it is to be a truly effective national program, and if it is to serve efficiently as a basis for various action programs. This is particularly appropriate because the work is centered primarily in the field with 12 separate regional land-use planning sections having the immediate responsibility for the adaptation of the national program to regional State and local needs and conditions, and for supervision, unification, coordination, and execution of the program within their respective regions. Many land-use problems cross regional boundaries; problems are continually arising as to the scope, content, organization, and application of land-use planning work as it progresses; many of the results of field work must have Nation-wide comparability; facts and recommendations must be synchronized with action. These and other problems constantly arise and require appropriate disposition. The Administrator has delegated the responsibility for the formulation of the national program, the technical guidance and direction of all lines of work, and the coordination of the land-use planning program as a whole to the Director of the Land Utilization Division, who, in turn, relies upon the Land Use Planning Section in Washington to handle most of these functions.

LAND-UTILIZATION PROJECTS

The action program of land utilization consists of the purchase, in 206 projects, of 9,148,903 acres of land which is unsuitable for crop cultivation, and the development of most of this area for other uses such as forestry, grazing, wildlife conservation, and recreation. The Land Utilization Division has also acquired land for rural-resettlement projects of the Administration.

Planning work for these projects during the year has been primarily concerned with the developments completed or now being undertaken on the purchased areas. In addition to general project plans, approximately 7,000 individual job plans have been worked up in the field, and reviewed in Washington from both an engineering and economic viewpoint. The development of submarginal areas has been guided wherever possible into channels that will contribute to major policies of conservation and agricultural rehabilitation.

Although land-utilization projects of the Administration have not been established primarily as flood-control measures, nevertheless water conservation is

being furthered by developments which retard the rate of surface run-off, increase percolation into the soil, and to a lesser degree by those which impound the run-off of streams and storm water.

In the development of recreational areas in connection with land-use projects, the submarginal-land program has made play areas available to local populations badly in need of such facilities. Special attention is being given to practical sanitary installations on these demonstrational areas which will help educate the farmer to a recognition of the need and opportunity for better sanitary conditions in and around his own dwelling.

Improvement of these areas of unproductive land will result in many of these land-use adjustment projects becoming self-liquidating. The sale of timber products, logging permits, turpentine leases, grazing fees, hunting and fishing privileges, and the renting of cabins and camps for recreational use are among the sources of revenue which these projects should produce when development work has been completed.

Table 1 lists the acreage and costs of the land-purchase program by types of projects.

TABLE 1.—*Estimated costs of land and land acquisition for land-use adjustment projects, by type of project, as of June 30, 1937* [1]

Type of project	Projects	Land to be purchased	Estimated cost			Average cost per acre	
			Land	Aquisition	Land and acquisition	Land	Land and acquisition
	Number	*Acres*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Agricultural adjustment	98	6,806,465	27,360,465	2,600,049	29,960,514	4.02	4.40
Indian	30	1,218,395	3,554,986	66,479	3,621,465	2.91	2.97
Migratory waterfowl	32	722,551	5,664,747	349,049	6,013,796	7.84	8.32
Recreational [2]	46	401,472	4,344,009	404,172	4,748,181	10.82	11.83
Total or average	206	9,148,903	40,924,207	3,419,749	44,343,956	4.47	4.85

[1] Includes expenditures under the following appropriations: Loans and relief in stricken agricultural areas, Resettlement Administration submarginal land, 1934 and 1935; National Industrial Recovery, Resettlement Administration, submarginal lands, 1933–37; Emergency Relief, Resettlement Administration, sanitation, prevention of soil erosion, etc., 1935–37. Does not include expenditures for acquisition made under the Federal Emergency Relief Administration.

[2] Data for recreational land-use projects does not extend beyond Nov. 14, 1936, the date upon which these projects were transferred from the jurisdiction of the Resettlement Administration to the National Park Service.

LAND ACQUISITION

Table 2 included herewith indicates the progress in land acquisition work during the past fiscal year. On June 30, 1937, title to 4,922,064 acres was vested in the United States, which is 56 percent of the total land to be acquired in this program. Options have been accepted and title work is under way for the remaining acreage.

TABLE 2.—*Status of acquisition of land-use projects*

Status	June 30, 1936			June 30, 1937		
	Area involved	Cost	Completed	Area involved	Cost	Completed
	Acres	*Dollars*	*Percent*	*Acres*	*Dollars*	*Percent*
Options accepted	8,959,131	39,010,063	98	[1] 8,747,431	[2] 36,597,967	100
Title perfected	4,426,672	20,598,666	49	7,646,767	31,684,284	87
Preliminary opinions received	4,104,166	19,034,351	45	7,375,853	30,703,397	84
Checks delivered	2,240,667	10,656,034	24	5,404,231	22,632,389	62
Title vested in United States	1,744,342	7,796,410	19	4,922,064	20,324,616	56

[1] This acreage equals the total acreage to be purchased, as shown in table 1, minus 401,472 acres included in the 46 projects transferred to the National Park Service on Nov. 14, 1936.

[2] The estimated cost of land as shown in table 1 is slightly lower than the amount committed for land as given here, because more exact determinations of acreages were made for certain tracts after options had been accepted.

An important development during the year has been the improvement of the procedure followed in moving land-acquisition accounts through the many different Federal offices which, according to the law, must pass upon them. A heavy accumulation of unsettled accounts a year ago made action of this sort imperative.

FUTURE ADMINISTRATION OF PROJECTS

Seventy-five percent of all the land in this submarginal-land program is found in the 98 agricultural land-use adjustment projects which are the direct responsibility of the Land Utilization Division. Work has been initiated during the year to effectuate plans for the future administration of these areas by both Federal and State agencies. It is planned to have 46 projects turned over to the control of State conservation commissions and other State agencies. Six projects are intended for administration by the Forest Service; three others, by the War Department. Seven project areas will be administered by the Resettlement Administration or its successor in cooperation with the Division of Grazing, Department of the Interior. Plans for the future administration of the 36 remaining projects have not yet been completed.

By Executive order on November 14, 1936, 46 projects, involving 401,472 acres, were transferred to the National Park Service, Department of the Interior, for completion. Land in these projects will be devoted primarily to recreational use and the National Park Service, now having complete charge of them, will arrange for their future management as park areas.

Thirty projects, involving 1,218,395 acres, were planned in cooperation with the Office of Indian Affairs, Department of the Interior, to be used primarily for Indian rehabilitation. Arrangements have been made for the transfer of 21 of these projects to the Office of Indian Affairs, Department of the Interior, for administration. The future use and administration of the other nine projects is now the subject of study by a joint committee appointed by the Secretaries of the Interior and Agriculture.

Thirty-two projects, involving 722,551 acres, were planned in cooperation with the Bureau of Biological Survey for the purpose of protecting migratory waterfowl. The lands in 27 of these projects have been proclaimed migratory waterfowl refuges by Presidential proclamation and are already under the jurisdiction of the Biological Survey.

PROJECT DEVELOPMENT

Land-development work has been carried out by the Land Utilization Division on 94 projects, involving 6,730,942 acres. This work has provided employment for a maximum of 42,700 relief workers certified by the Works Progress Administration, and 13,300 men whose farms were purchased in the submarginal-land projects. Work has been carried out to date at a cost of $675 per man-year.

Achievement of the best multiple use of the submarginal land in these projects has been the objective of the development work. In the forested eastern part of the United States, development of lands unsuited to crop farming is directed toward nonagricultural uses, such as forestry, recreation, and wildlife conservation. In the Great Plains and intermountain regions, on the other hand, development of the program involves primarily the improvement of range facilities for livestock grazing.

A brief summary of some of the work which has been undertaken up to June 30 will give an indication of the varied improvements that are being undertaken on these 94 projects. More than 100,000 check dams have been built to control water run-off and to check erosion. Three hundred and eighty-two thousand acres of forest land have been improved. Approximately 73,000,000 forest trees have been planted. Roads and truck trails on these projects, if strung out in a line, would reach across the continent—more than 3,000 miles. The public will find available on these projects more than 7,200 acres of camping and picnic grounds. Thirty-five fish ponds and hatcheries have been developed and approximately 18,000 acres have been subjected to biological conditioning for the purpose of improving wildlife environment. A list of the amount of work done on the more important jobs to date is found in table 3.

TABLE 3.—*Work completed on major jobs in the land-development program to June 30, 1937*

Job no.	Classification	Work accomplished	Job no.	Classification	Work accomplished
105	Marking boundaries ..miles..	1,917	303	Park roads.....miles..	1,052
108	Clearing land.....acres..	22,914	304	Truck trails.....do....	2,551
113	Obliterating farmstead buildings.....number..	1,870	305	Road repairs.....do....	1,271
114	Obliterating fences....miles..	1,683	306	Foot trails.....do....	219
118	Obliterating structures number..	142	307	Bridle paths.....do....	49
125	Seeding.....acres..	45,280	401	Check dams.....number..	263,058
201	Footbridges.....number..	36	402	Diversion ditches.....rods..	41,572
202	Horse bridges.....do....	39	403	Stream and bank protection acres..	345
203	Vehicular bridges.....do....	450	404	Terracing.....rods..	13,285
205	Administrative buildings number..	78	501	Catch basins.....number..	6
206	Barns.....do....	19	503	Reservoir site preparation acres..	9,442
207	Bathhouses.....do....	13	505	Culverts.....number..	894
208	Boathouses.....do....	4	510	Concrete riprap—paving square yards..	3,922
209	Overnight cabins.....do....	101	601	Firebreaks.....miles..	1,880
210	Combination buildings number..	16	602	Fire-hazard reduction..acres..	153,380
211	Contact buildings.....do....	4	603	Nurseries.....do....	117
212	Dwellings.....do....	24	604	Stand improvement...do....	409,402
213	Garages.....do....	38	605	Tree planting and seeding acres..	87,611
214	Latrines.....do....	113	608	Timber harvested M board feet..	12,254
215	Lodges.....do....	6	609	Fire control (labor) man-hours..	192,299
216	Lookout houses.....do....	9	701	Beach improvement square rods ..	65,851
217	Lookout towers.....do....	90	703	Moving and planting trees and shrubs.....number..	139,732
219	Recreation buildings..do....	5	704	Parking areas..square rods..	23,224
220	Shelters.....do....	69	705	Public camp and picnic grounds.....acres..	7,346
221	Storage houses.....do....	46	706	Walks.....square yards..	62,093
222	Construction camp barracks number..	116	707	Wayside parks....number..	8
223	Blacksmith shops.....do....	65	708	Swimming pools.....do....	79
226	Impounding dams....do....	1,354	801	Biological conditioning acres..	51,131
228	Fences.....miles..	95	803	Fish-rearing ponds and hatchery.....number..	39
229	Fence posts harvested number..	118,171	804	Food and cover planting acres..	12,258
231	Camp fixtures.....do....	1,763	805	Game farms.....number..	8
232	Cattle guards.....do....	193	807	Lake and pond development acres..	24,300
233	Corrals.....do....	20	808	Stream improvement..miles..	261
234	Dippings vats.....do....	6	809	Predatory-animal control acres..	387
235	Guardrails.....lineal feet..	28,319	904	Restoration of historic structure.....number..	1
236	Levees, dikes, and jetties miles..	69			
237	Power lines.....do....	49			
238	Sewerage systems..number..	30			
239	Telephone lines.....miles..	1,777			
240	Waste systems.....number..	5			
241	Water systems.....do....	308			
243	Treating tanks.....do....	12			
302	Highways.....miles..	116			

One of the important achievements in this program has been the training of previously unskilled workers to do capable work as carpenters, masons, mechanics, etc. A large number have been able to find jobs in private employment as a result of the training thus received.

In a notable number of instances the efficiency with which the land-development work has proceeded with the use of relief labor has been gratifying. The cost records of one of several large dams being built in Oklahoma, which is approximately 60 percent completed, indicate that the unit cost per cubic yard of earth fill is right in line with the unit cost per cubic yard on two similar dams in the same locality based on figures submitted by 12 competing contractors on a contract basis. The unit cost records on dams still under construction in Indiana also compare very favorably with current unit costs under the contract system.

SAMPLE PROJECTS

A picture of the multiple-purpose developments on submarginal land may best be obtained by viewing the work on two different projects. Characteristic of the land development work in the Great Plains region is that being undertaken on the 935,521 acre Milk River project in Phillips, Valley, and Blaine Counties, Mont. The objective of the development work here is to convert overgrazed pasture and abandoned farm lands into a productive range capable

of serving as the basis for permanent and stabilized livestock operations. Grass is being restored on the land both by giving it a period of rest in which to recuperate, and also by reseeding areas where destruction of the grass has been most serious. Improvement of water facilities also plays an important part. A large number of check dams and stock reservoirs are being built in order to conserve the small amounts of rainfall and to distribute the water supplies for cattle throughout the area in a way that will promote its best use. Buildings which cannot serve any purpose in the new use of the land have been obliterated, and fences have been changed in line with the new pattern of use for the area. Some recreational potentialities in this project area are also being realized. A complete list of jobs carried out this year, that indicates the scope of the development work, follows.

Individual jobs included in approved development plan for Milk River, northern Montana project LD–MT–2

Grazing developments:		
Cover surveys	acres	4,000,000
Drainage surveys and maps	do	340,000
Obliterating farmsteads	number	577
Obliterating fences	miles	872
Rodent control	acres	321,800
Seeding	do	20,700
Diversion dams	number	58
Impounding dams (stock water reservoirs)	number	677
Fence construction	miles	637
Cattle guards	number	50
Corrals	do	22
Dipping vats	do	19
Spring development	do	175
Terracing and contour furrowing	acres	16,080
Forest development:		
Stand improvement	acres	2,550
Tree planting and seeding	number	150
Food and cover planting	acres	840
Truck trails	miles	5
Recreational development:		
Overnight cabins	number	15
Camp fixtures	do	90
Telephone lines	miles	4
Public camp and picnic grounds	acres	340
Bathhouse	number	1
Latrines	do	5
Recreational buildings	do	4
Water system	do	1
Sewerage system	do	1
Park roads	miles	10
Fine grading	square rods	700
Transplanting trees	acres	60
Swimming pool	number	1
General development:		
Administrative buildings	number	1
Garage	do	1
Storage houses	do	2
Construction camp barracks	do	20
Construction camp mess halls	do	20
Highways	miles	99
Power lines	do	4

This work was about 60 percent completed on June 30.

The sand-hills project in North Carolina illustrates developments undertaken in the naturally forested eastern part of the United States. Forest-stand improvement is a leading job. Because of the need for forest-tree stock in order to restore this sandy area to forest cover, a forest-tree nursery was one of the first things to be developed on the sand-hills project. During the year this nursery furnished approximately 13,000,000 seedlings which were used not only on the sand-hills project itself but in other southern areas where similar conditions prevail.

Wildlife development is also receiving considerable emphasis on the sand-hills project. A fish hatchery has been established to provide fish for the restocking of streams and lakes in the project area and to furnish brook stock for other projects in the Southeast. Protective cover for upland game, as well as food crops for game birds, are being introduced into the project area. Recreational facilities on this project include the development of an artificial lake, and the building of cabins, trails, camping areas and picnic grounds for the use of the large nearby and transient population. A summary of jobs on this project follows.

Individual jobs included in approved development plan for sand-hills project LD–NC–3

Forest development:		
Firebreaks	miles	500
Fire-hazard reduction	acres	1,000
Nursery	number	1
Stand improvement	acres	40,000
Tree planting and seeding	do	19,500
Timber estimating	do	12,000
Timber harvested	M board feet	1,700
Fire protection and control	acres	63,000
Seed collection	pounds	7,000
Bridges	number	20
Administration buildings (repair work)	number	4
Dwelling (warden's residence)	do	1
Truck trails	miles	65
Road repair	do	15
Recreational development:		
Park roads	do	5
Bath house	number	1
Overnight cabins	do	20
Dwellings (caretaker)	do	2
Bunkhouses	do	10
Lodge (4-H camp)	do	1
Recreational pavilion	do	1
Recreational building	do	1
Shelters	do	6
Impounding dams	do	10
Piers	do	3
Boathouse	do	1
Waste systems	do	4
Officers' quarters (4-H club)	do	1
Washrooms (4-H club)	do	2
Craft shop (4-H club)	do	1
Recreational development—Continued.		
Park roads (reconstruction)	miles	12
Beach improvement	square rods	500
Trailer camp	number	1
Wildlife conservation:		
Combination building	do	1
Fish hatchery	do	1
Dwellings (hatchery residences)	do	2
Fences (new construction)	miles	1
Fences (repair)	do	60
Food and cover planting	plots	200
Game farm	number	1
General:		
Cover surveys and maps	acres	60,000
Topographic surveys and maps	do	1,700
Obliterating farmsteads	number	50
Sodding	square yards	25,000
Soil preparation	acres	20
Bridges and culverts	number	2
Garages	do	7
Latrines	do	12
Guard rails	lineal feet	2,000
Power lines	miles	6
Telephone lines	do	12
Water systems	number	7
Sewerage systems	do	12
Entrance gates and markers	do	4
Airplane landing field	do	1
Earth excavation	cubic yards	27,000
Moving and replanting trees	number	38,000
Parking areas	square rods	12,500
Public camp and picnic grounds	number	1

This work was about 40 percent completed on June 30.

RESETTLEMENT PROJECTS

Work on resettlement projects represents a consolidation of the activities of three previous divisions of the Resettlement Administration—rural resettlement, management, and special skills. This reorganization, which included as well the transfer of certain parts of the Suburban Resettlement Division, was carried out during April 1937 in recognition of the changed emphasis on this branch of the Administration's work. With the progress made during the past year and a half, the need for planning activities was diminished, and the need grew for an organization equipped to supervise the operation and maintenance of projects.

STATUS OF PROGRAM

On June 30, 1937, there were 122 active resettlement projects, which will provide homes for approximately 14,000 families. These included several projects transferred to the Resettlement Administration from the former Division of Subsistence Homesteads, Department of the Interior, others brought from the Federal Emergency Relief Administration, and new projects planned and developed entirely under the Administration since its establishment. Of these projects, 38 were completed on June 30, providing homes for 1,957 families; 84 were under way. Table 4 shows the status of active projects in each region.

TABLE 4.—*Status of active resettlement projects by regions, June 30, 1937*

Region	Construction			Region	Construction		
	Completed	Under way	Total		Completed	Under way	Total
I	0	6	6	VIII	6	8	14
II	1	10	11	IX	3	4	7
III	3	5	8	X	0	4	4
IV	2	11	13	XI	1	2	3
V	7	14	21	XII	2	1	3
VI	5	15	20				
VII	8	4	12	Total	38	84	122

Some families have been permitted to take up residence on certain projects still in the construction stage. These, together with those occupying the 38 completed projects, make a total of 4,441 families who were living on resettlement projects on June 30.

During the year four projects have been conveyed by the Administration to local homestead associations which serve as operating agencies under the general guidance of the Administration. Projects conveyed were Decatur Homesteads, Ind.; Hattiesburg Homesteads, Miss.; Meridian Homesteads, Miss.; and Phoenix Homesteads, Ariz. These 4 projects, in addition to 8 projects conveyed prior to July 1, 1936, make a total of 12 projects conveyed to homestead associations to date. In addition, six homestead associations were formed during the year, and plans for the conveyance of the projects to these associations are now progressing.

Acquisition of land for the resettlement projects has been carried on through the cooperation of the Resettlement Division and the land-acquisition office of the Division of Land Utilization. On June 30, practically all funds allocated to the purchase of resettlement farms had been committed through the acceptance of options. A total of 550,786 acres is being acquired at a total cost of $19,368,085. Title has been finally acquired to aproximately 40 percent of this acreage, the remaining tracts being still involved in the process of title clearance. Table 5 gives the progress of land acquisition for resettlement projects.

TABLE 5.—*Status of acquisition on rural resettlement projects*

Status	June 30, 1936			June 30, 1937		
	Area involved	Cost	Completed	Area involved	Cost	Completed
	Acres	*Dollars*	*Percent*	*Acres*	*Dollars*	*Percent*
Options accepted	257,896	9,420,560	47	550,786	19,368,085	100
Titles perfected	18,886	695,289	3.4	411,364	15,488,819	74.7
Preliminary opinions received	17,588	608,798	3.2	382,599	14,536,630	69.5
Title vested in United States	3,845	123,261	.69	190,582	6,936,878	34.6

FARM AND HOME MANAGEMENT

Basic planning activities for the resettlement projects during the year involved completion and approval of 93 project plans. In addition to setting up adequate plans for new projects, it was necessary to revise drastically the plans for a number of the projects that were transferred to the Resettlement Administration from other agencies.

For each of the approved projects there are now available a detailed presentation of the agricultural economy on which it is based, and farm and home plans for each type of farm unit. Farm-management plans for these projects are in almost every case based upon improved methods of farm operation as compared with the past practices of resettlement clients.

Certain changes in policy concerning resettlement projects, which have been previously referred to, have altered the character of planning activities. The infiltration type of project, in which individual farm units are developed in established communities, has received heavier emphasis than has the plan of developing completely new resettlement communities. Moreover, costs have been lowered in accordance with the adoption of the following maximum figures. In the South: Dwellings, $1,200; barns, $500; poultry houses, $100; sanitation, $55; water, $250; fencing, $250; smokehouses, $100. Outside of the South: Dwellings, $2,100; barns, $500 to $1,500; poultry houses, $100 to $250; sanitation, $55; water, $250; fencing, $250.

REAL PROPERTY CONTROL

Maintenance and operation of projects has been one of the principal growing functions of the Administration. Collections of payments due the Government from clients in projects have been on the whole satisfactory. On June 30, $529,887.64 was due, and of this amount $490,759.94, or 92.6 percent had been collected. On 70 projects, payments by clients will not be due until after the sale of this year's crop.

In order to protect the Government's investment, an insurance plan has been devised with a group of well-known mutual insurance companies. Several stock

insurance companies are also preparing a policy to cover resettlement projects that will meet the requirements of the Administration and compete with the facilities offered by the mutual companies. This insurance program, which has already proved worth while in the case of losses that have occurred, has been of interest and value to other Federal agencies, particularly the Forest Service and the Rural Electrification Administration.

Under legislation passed by Congress, the Resettlement Administration is authorized to make payments in lieu of taxes to local governments, in order that they may not be embarrassed by the withdrawal of land from taxation as a result of projects that often create an increased demand for public services. Thirty-three agreements providing for such payments have been signed and 104 are in process of negotiation.

COMMUNITY AND FAMILY SERVICE

During the past year, 13,459 applications for resettlement homes and farms were received. Of this number, approximately 1,750 families were accepted and placed in homes and farms after the qualifications and needs of all applicants had been investigated. Plans are now being made for the selection of families to occupy the three green-belt towns, which will involve an even larger piece of work than has been carried out in this field to date.

Special attention has been given to the development of schools and to the community facilities in resettlement projects. This has involved the careful cooperation with county, State, and Federal educational agencies in order to develop schools that may be satisfactorily integrated with the existing school systems. Practically every resettlement project of the community type has presented its own particular problems in this regard.

The Resettlement Division has also developed various methods of helping families living on land-utilization projects to find homes and adequate opportunities for work elsewhere. Some of these families have been accepted as clients for resettlement projects, others have been guided into the rehabilitation program, while a special group has had to be taken care of through arrangements with State and local welfare agencies.

The development of cooperatives has played an important part in the resettlement program. Forty-seven cooperative associations have been organized, and others will be formed wherever they are found essential to the economic success of the projects. These are general cooperatives embracing a wide variety of activities interlocked with the agricultural economy of the projects. Their functions range from production and processing to purchasing, marketing, and services. Practically all of them have been designed to serve not only the clients of the resettlement projects, but also the farmers of nearby communities who can benefit from such organizations. Because of the need for creating an understanding of cooperative principles among all participants, educational activities along cooperative lines have been undertaken as a part of this work.

SPECIAL SERVICES

Many special activities of a varied nature have been found necessary in the development of resettlement projects. They include the design of furniture for resettlement homes and the arranging for manufacture and delivery by private industry. Special programs involving such activities as weaving, woodwork, dramatics, landscaping, and music have helped to increase both the economic and cultural level of resettlement projects. Some mural and sculptural work has been developed for community buildings in certain of the projects. The work in regard to special services of this nature has filled a real need, and it is felt that the services rendered under this phase of the program could be of great value to other bureaus and divisions of the Department.

One of the primary reasons for initiating the resettlement projects was to provide useful work for the unemployed. The great majority of work on these projects has been performed by persons taken from the relief rolls. This policy has resulted in the employment of many thousands of skilled and unskilled workers who were unable to find work elsewhere.

GREEN-BELT TOWNS

Work has proceeded rapidly during the past year on the construction and organization of three suburban green-belt towns; Greenbelt, Md., near Washington, D. C.; Greenhills, Ohio, near Cincinnati; and Greendale, Wis., near Milwaukee.

The greatest significance of the green-belt projects lies in the demonstration they make of new methods of town planning. Because they have been planned from the very beginning and developed on what might be called raw land, it has been possible to design these towns with the fullest consideration of all the physical elements that contribute to a satisfactory family and community life. The progress in construction work during the past year has translated these plans into reality. By the first of October, it is expected that the first tenants will occupy homes in Greenbelt, Md., the first of the three projects to get under way.

An outstanding feature of the suburban program has been the tremendous interest invoked by these projects not only among town planners, architects, and civic leaders, but also among the whole population of the nearby cities. On the basis of records kept at each project it is estimated that 1,200,000 people visited the three green-belt towns between July 1, 1936, and June 30, 1937.

PROGRESS OF WORK

The status of construction work on the three projects is shown in table 6. Although no homes were technically listed as completed on June 30, a great many homes at Greenbelt, and some on other projects, were completed except for minor installations and finishing work. A total of 2,133 family dwelling units will be completed in the three projects.

TABLE 6.—*Status of construction work on three Greenbelt projects*

Item	June 30, 1936	June 30, 1937	Increase
Dwellings under construction ... family units	756	2,133	1,377
Foundations completed ... do	483	2,133	1,650
Roofs finished ... do	69	1,613	1,544
Nonresidential under construction ... buildings	2	11	9
Roads ... percent completed	5	45	40
Sewers ... do	16	87	71
Water mains ... do	5	89	84

The creation of employment was one of the leading practical reasons for the carrying out of these projects under the Emergency Relief Act. During the year, the average semimonthly pay roll for the three green belt projects show a total employment of 7,037 men, of whom 67 percent were relief workers (table 7). Nonrelief labor on these projects consisted primarily of skilled workers who could not be obtained from relief rolls.

TABLE 7.—*Labor employed on three Greenbelt projects*

[Average semimonthly payroll, July 1, 1936 to June 30, 1937]

Project	Relief labor	Nonrelief labor	Total
	Number	*Number*	*Number*
Greenbelt	2,037	1,221	3,258
Greenhills	1,367	695	2,062
Greendale	1,234	483	1,717
Total	4,638	2,399	7,037
Percentage of total	67	33	100

The more dramatic features of planning work in connection with the green-belt towns—namely, the development of the green-belt principle by which each town is surrounded with a protective area of woodland and farms, the design of street systems and the determination of the architectural character of each project—was completed during the previous year. During the 12 months ended June 30, planning work was concerned with more detailed activities such as the preparation of working drawings. The production of these plans has been practically completed as evidenced by table 8 showing the percentage of completion for three types of planning.

TABLE 8.—*Planning activities at Greenbelt projects*

Item	Completed June 30, 1936	Completed June 30, 1937
	Percent	*Percent*
Residential working drawings	56	99
Nonresidential plans	25	95
Utility plans	41	97

Of the 21,530 acres being purchased in connection with the three green-belt projects, all but 1,827 acres have been acquired. The progress of land acquisition during the year is indicated in table 9.

TABLE 9.—*Land acquisition in connection with Greenbelt projects*

Item	June 30, 1936	June 30, 1937
Area to be acquired ... acres	21,530	21,530
Paid for and closed ... do	14,272	19,763
Tracts paid for and closed ... number	216	328

An important feature of the year's work has been the computation of the costs of construction and the costs of future operation for these towns in order to decide upon a proper scale of rentals. In regard to Greenbelt, these studies reached a final stage at the close of the year, and an announcement of the complete financial plan of this town was being prepared for release shortly afterward. Similar studies are under way for the other two projects. A complete statement of the percentages of the total jobs allocated to each major phase of the three projects is given in table 10.

TABLE 10.—*Percentages of the budgets allocated to major phases of Greenbelt projects*

Division and item	Green-belt	Green-hills	Green-dale
Suburban Division:	*Percent*	*Percent*	*Percent*
Planning expense	3.6	5.1	5.4
Real-estate purchase	7.8	14.2	12.2
Land-acquisition expense	.5	.4	.4
Total	11.9	19.7	18.0
Construction Division:			
Surveys	1.1	1.2	1.0
Land preparation	1.2	1.5	.4
Road and street construction	2.4	3.7	4.5
Sewerage system	3.8	4.2	3.9
Water-supply system	1.8	3.2	3.6
Electric-distribution system	.4	1.9	1.9
Landscaping	4.5	3.7	2.8
Residential construction	44.9	43.4	35.5
Nonresidential construction	6.4	6.9	8.2
Overhead expense	16.2	5.3	12.4
Rural improvements	.2	1.9	2.6
Material inventory	.7	.2	.2
Equipment inventory	.7	.3	.5
Miscellaneous expense	.8	.1	1.3
Contingency	1.4	.9	1.2
Total	86.5	78.4	80.0
Resettlement Division	.6	.9	.8
Inspection Division	.5	.6	.7
Special Skills Division:			
Furniture	.4	.3	.4
Window equipment	.1	.1	.1
Total	.5	.4	.5

COMMUNITY ORGANIZATION

Inasmuch as each of the three suburban towns will include a child population of several hundred, the problem of working out satisfactory school plans has been a most important one. Educational facilities have been planned in order to make available in one building, without extra expense or duplication, adequate school facilities for the children of each town, as well as space for a public library, adult education groups, and such community enterprises as dramatics, music, and workshops. The educational programs for these towns have also been integrated with those of the districts or counties in which they are located, in order to avoid duplication and conform to the highest existing educational standards.

Thus, for example, at Greenbelt, Md., two school buildings are being built in accordance with an educational plan worked out with the board of education of Prince Georges County. One is an elementary school, situated near the center of the town. This building will serve the younger children of Greenbelt proper. At the same time its library will serve as the town public library, and its classrooms, auditorium, and workshops during nonschool hours may be used for adult education and various community activities. A high school is also being built at the western edge of the town property. This school is being erected in cooperation with the county board of education not only for Greenbelt's older children, but also for the high-school students of several other small towns adjoining Greenbelt which are in need of school facilities.

The same principles have been followed in the other two projects. Rather than attempt to set up a standard plan for schools in all three projects, however, the educational plan of each new town has been designed in accordance with the local needs and conditions that vary from one to the other. At Greendale, Wis., for example, only an elementary and junior high school is being built. Senior high-school students will be transported to a newly enlarged school at West Milwaukee where ample facilities are available. To build a new high school for Greendale would not involve unnecessary expense, but would probably seriously jeopardize the ability of the West Milwaukee school district to carry the bonded debt incurred for the enlargement of their existing school building. This treatment of the educational plans for the green-belt towns conforms to the basic policy of the program, which has been to develop town plans related as closely as possible to the immediate local conditions encountered. Likewise the school plans have been developed with a view to taking care of future increases in population without any drastic changes or additions being necessary.

When the suburban projects have been occupied and local management corporations formed, it is anticipated that wherever local conditions permit all property now held by the Resettlement Administration will be turned over to them. Through these organizations residents will manage their own affairs and pay the usual taxes to local governments. Pending the completion of these arrangements, agreements have been made between the Administration and local governments providing for payments in lieu of taxes.

Plans have also been completed for most of the utilities for the three towns, and necessary arrangements have been made with producers of electric power, telephone service, water supply, and transportation.

GREENBELT CHARTER

In April 1937, the Maryland Legislature passed an act incorporating the town of Greenbelt and establishing it as the first incorporated municipality in the State with a city-manager form of government. Under this charter residents of the town on November 23, 1937, will vote for five members of a town council to serve until September 1938. This council will appoint a city manager who will have responsibility for the execution of policies established by the council and will have full control over the appointment of municipal employees. The council will also select one of its own members as mayor to serve as the titular head of the town. Establishment of this model form of municipal government for Greenbelt is welcomed as an act which secures for this town a political organization in keeping with its high standards of social planning.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - Price 5 cents

REPORT OF THE CHIEF OF THE BUREAU OF PUBLIC ROADS, 1937

United States Department of Agriculture,
Bureau of Public Roads,
Washington, D. C., September 15, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I submit herewith the report of the Bureau of Public Roads for the fiscal year ended June 30, 1937.

Sincerely yours,

Thomas H. MacDonald, *Chief.*

CONTENTS

INTRODUCTION

More than 22,000 miles of highway of all classes were brought to completion under Bureau supervision in the fiscal year, exceeding by several hundred miles the work completed in the previous year and also the record of 21,700 miles completed in 1934. For the past 4 years road construction supervised by the Bureau and financed in whole or in part with Federal funds, with the primary objective of providing employment to those on relief rolls, has progressed at a rate of approximately 20,000 miles a year. Although the volume of such work remained large, the past year was definitely a period of transition from an emergency program to the more normal Federal-aid road-construction operations.

21283—37——1

Emergency funds available for new projects were reduced to a small remainder at the end of the year. Considerable emergency work under construction was carried over into the new year and when this is completed the emergency program will have been practically concluded.

While the end of the year marks the last stage of the emergency road-construction program it also marks the beginning of a broadened Federal-aid program. Improvement of the Federal-aid highway system, begun in 1921, is being continued and two new classes of Federal-aid operation are being initiated—Federal aid for secondary or feeder roads and for the elimination of hazards at railroad grade crossings. Federal participation in these classes of work was begun in the emergency program with direct grants of funds and is to be continued under specific Federal-aid authorizations of $25,000,000 for secondary-road improvement and of $50,000,000 for elimination of hazards at grade crossings in each of the fiscal years 1938 and 1939.

AVAILABLE FUNDS INSUFFICIENT FOR HIGHWAY NEEDS

During the pioneer period of road development the attention of State and Federal Governments was properly centered on the Federal-aid system, the network of main rural highways of interest to all classes of highway users. The initial surfacing of most of this system has now been completed, and service is being given to a rapidly growing and altering traffic of tremendous economic and social significance; but much remains to be done to provide an entirely adequate service. Meanwhile there has developed a widespread and justified demand for better road service for communities not directly on the main highway system, a demand which has been answered in a measure by the congressional provision for improvement of secondary and feeder roads. And, at the same time, it has been recognized that extension of the main routes into and through cities is a general responsibility. Such routes are rapidly being placed under the care of State highway departments, and, beginning with the fiscal year 1936, Federal aid became available for extensions of the Federal-aid system into and through cities. In consequence of these developments, State and Federal highway officials are now confronted with the necessity of planning and constructing three important classes of highways—the main rural highways, extensions of these routes through cities, and the secondary or feeder roads.

It is now evident that the States must depend mainly on special revenue from road users for funds with which to carry on this work. Property taxes and appropriations from general funds for highways have shrunk to small proportions and there is little reason to expect that they will be increased, yet nearly one-sixth of present motor-vehicle revenues are being assigned to nonhighway uses. Federal contributions are continued but not on the scale of the past 4 years when large emergency funds were made available. The new fund of $25,000,000 for secondary and feeder roads represents an increase in regular Federal-aid funds and will provide a considerable mileage of much needed roads but the sum is small compared with the needed mileage of feeder roads. However, these funds have an important and timely significance in that they place this important problem in the hands of State and Federal road-building agencies and give to them the opportunity for orderly planning of the larger operations that must follow if a satisfactory solution is to be had.

The State highway departments, confronted with increased responsibilities out of all proportion to the revenues available to them and pressed with sound arguments to provide improvements in all directions, face difficult problems in administration.

IMPROVEMENT OF MAIN HIGHWAYS MUST CONTINUE

Improvement of secondary roads is important but such work must not be allowed to impede the necessary further work on the main highways. Construction of through routes was begun some 15 or 20 years ago when the speed of vehicles was much slower and traffic considerably less in volume. The roads built were designed for conditions as they were then foreseen, and were influenced somewhat by the necessity of rapidly extending the mileage. Engineering standards in respect to sight distance, curvature, and grade have been steadily raised but much of the early construction reflects the earlier lower standards and is unsafe for modern traffic. The outstanding reason for continued improvement of the main highways is to permit travel with facility and safety. The condition of these highways cannot be considered satisfactory so long as many sections present unexpected dangers to the motorist.

Grade crossings continue to take an annual toll in lives and may be expected to continue to do so as long as they remain on heavily traveled roads. Many have been eliminated with Federal funds in the emergency program and the regular Federal aid now provided for grade-crossing eliminations will continue this work on a reduced scale. But the great number of crossings still existing present a difficult problem to the highway administrator.

Confronted with these various and urgent needs and with limited funds at their disposal, highway officials find their problems more difficult than ever before. It is of the greatest importance that there be a clear understanding of the essential needs for each class of improvement in order that funds may be allotted fairly and with due recognition of the needs of all classes of highway use. It is also important that there be a more accurate measure of the extent of the improvements needed on each class of road in order that we may know the cost and plan operations without misunderstanding as to how much can be accomplished. To this end highway-planning surveys are now being conducted in 44 States with Federal assistance and according to a general plan prepared by the Bureau that will result in a complete picture of our present highway situation. For the first time, as a result of the studies, the actual present condition of all highways will be determined and clear indication will be given as to the extent of further improvement that will be justified by present and future traffic. Progress in the surveys is described on page 65.

SELECTION OF SECONDARY ROADS FOR IMPROVEMENT ONE OF IMPORTANT OBJECTIVES OF SURVEYS

Selection of those secondary roads that should be ranked as having first priority for improvement is one of the primary objectives of the planning surveys. In general the selection can be guided by present traffic and that traffic which will be attracted from other unimproved highways as a result of improvement. The roads so selected will be desirable improvements. However, it may not be in the best interest of the country as a whole to follow this method invariably. It is believed by many that a better national economy will result by bringing about a shift of population from lands of low productivity to those of high productivity. The Department is now making an exhaustive study of the benefits that may accrue to the agricultural producer and to the consumer from better land utilization and it appears that the selective improvement of secondary roads may be an important instrumentality for bringing about an eventual resettlement more consistent with the greater economic and social good of the Nation. Improvement can be withheld from roads serving lands of low productivity and extended to those capable of higher production. Such a course is logical if the matter is considered solely from the viewpoint of earnings accruing to highway funds from investments in highway construction. In many cases roads through submarginal lands can be constructed only through a subsidy that in effect comes from the users of other highways. It is always true that those secondary roads serving the richest lands are the biggest producers of highway revenue.

HIGHWAY SAFETY

The thousands of people killed and injured each year in motor-vehicle accidents place upon highway officials the responsibility of making the highways as safe as they can be made. It is probable that highway conditions contribute to only a small proportion of the accidents, and it must be realized that no matter how safe the highways are made, accidents will continue to occur, but this does not lessen the necessity for removal of many dangerous conditions as rapidly as available funds permit. There is general agreement that the main highways must be raised uniformly to standards of improvement that are adequate for present traffic conditions. During the year a committee of 12 outstanding experts in highway engineering was appointed by the Secretary of Agriculture to work with the Bureau in the development of design standards for the promotion of safety of traffic and the advancement of the utility of highways to a maximum degree. Members of the committee are all State highway officials and the work being done has the full support of the American Association of State Highway Officials. Research work is being done by the Bureau as an aid to the committee in establishing standards concerning such matters as road widths, maximum grades and curvature, design of multilane highways, protection of grade crossings, and many other problems that enter into highway construction.

During the year the Bureau conducted studies of traffic conditions and measures for their improvement as directed by Congress in 1936 to the extent possible within the limits of the $75,000 authorized to be expended for the purpose.

For the purpose of bringing to bear upon the different problems the best thought of those who have been giving them long and careful study, the Bureau arranged for cooperation with the Highway Research Board of the National Research Council and other agencies in the development of the required reports. An advisory committee composed of those who are nationally recognized in the field of traffic safety and who represent organizations that have been giving the subject long study, was requested to act with the Bureau in the preparation of the reports and recommendations. In the research program, particular attention was given to three phases of the highway-safety problem:

(1) Detailed study of the lack of uniformity of State motor-vehicle laws which is regarded as an important contributing cause of highway accidents.

(2) Study of the characteristics and habits of drivers, including the identification of dangerous drivers.

(3) Improvement of the basic data, particularly accident reporting, needed for the study of accident causes and prevention.

Detailed investigations in this field were organized and carried on by the Bureau and through cooperation with the Highway Research Board.

At the close of the year a report to Congress discussing the data collected and making specific recommendations for action to be taken was nearing completion. The recommendations prepared for inclusion in the report are given on page 66.

The highway-planning surveys now being conducted in cooperation with the State highway departments will yield not only a detailed picture of those highway conditions that are substandard, and information as to the cost of raising them to satisfactory standards, but, for the first time, will supply something more than general intimation as to the effect of these conditions in causing accidents. Miles of travel by vehicles is an essential factor in making accident comparisons, and in every State where satisfactory accident statistics can be obtained they will be carefully related to the road conditions where accidents occur and to the volume of traffic at these places. The result should be a more definite indication as to the causes of accidents.

SPECIAL SERVICE HIGHWAYS WITH LIMITED ACCESS NEEDED

The large volumes of traffic that now flow between densely populated localities have created a demand for wide, multiple-lane highways, built according to the highest standards of grade and alinement, with opposing traffic separated by a center parkway, bypassing all cities, with structures separating streams of traffic at all highway and rail crossings, and with access from side roads permitted only at carefully selected points. Such highways offer great savings in time and in vehicle-operating costs to commercial vehicles, and to drivers of private vehicles they offer freedom from dangers of the highway and from other vehicles as nearly complete as it is possible to attain.

That large volumes of traffic would flow constantly over such highways between densely populated localities there is no doubt—a traffic large enough to justify the high cost of such improvement with reasonable assumptions as to the value of the savings in fuel and time and those resulting from greater safety and freedom of travel. However it is not readily apparent how any large mileage of such highways might be financed.

Since the benefits will accrue to the motor user it may be said that the cost should be paid by further motor-vehicle imposts. However motor-vehicle users are already heavily taxed and there are many motorists who would find little opportunity to use such highways. It may be that the most practicable way to obtain such improvements is through a form of payment that will be directly proportional to the amount of use—that is, through the payment of tolls.

Large volumes of traffic such as flow between thickly populated regions would be required to support the high cost; consequently the field of such special development will be definitely limited by the presence of a sufficient traffic volume.

SUMMARY OF HIGHWAY PROGRAM TO RELIEVE UNEMPLOYMENT

One of the major efforts of the Federal Government to relieve unemployment through a large-scale road-construction program began with an authorization of $400,000,000 as a direct grant to the States by the National Industrial Recovery Act of June 16, 1933. One year later the Hayden-Cartwright Act of June 18, 1934, authorized a supplementary $200,000,000. These funds are known as the 1934 and 1935 Public Works highway funds. The Hayden-Cartwright Act also provided $125,000,000 as Federal aid to the States in each of the fiscal years 1936 and 1937. The emergency program was continued by allocation of $200,000,000 for highways and $200,000,000 for grade-crossing elimination and protection, as direct grants to the States made from funds provided by the Emergency Relief Appropriation Act of April 8, 1935. These various acts also provided lesser amounts for the improvement of highways in national parks, national forests, public lands, and other Federal areas.

The work of highway construction carried out under these several acts had resulted, at the end of the last fiscal year, in the construction of 55,920 miles of road at a total cost of $956,138,230, of which $807,140,005 was paid by the Federal Government; and there were under construction, or approved for construction, 12,446 miles additional, involving an estimated total cost of $343,996,739, of which $200,395,350 was to be met with Federal funds. The remaining Federal funds available for new projects, including Federal aid for the fiscal year 1938, but exclusive of the new funds for secondary roads and grade crossings, amounted to $150,214,645. This amount consists largely of the Federal-aid authorization for 1938.

Under the grade-crossing program with both highway and special grade crossing funds, 1,849 crossings had been eliminated, 206 existing crossing structures reconstructed, and 737 crossings protected by safety devices at a total cost of $121,187,314, of which $116,478,687 was Federal funds. There were under construction or approved for construction 834 crossing eliminations, reconstruction of 151 existing elimination structures, and protection of 733 crossings with safety devices. The total cost of this work was estimated at $106,563,341, of which $102,433,856 was Federal funds. The emergency funds for elimination of hazards at grade crossings were practically all absorbed in completed or active work since only $8,729,528 remained for new work.

During the last 4 years the road construction described above and that carried on under other appropriations in Federal areas of various kinds has provided 7,700,000 man-months of direct employment, or an average rate of nearly 2,000,000 man-months per year, which is approximately double the average of employment furnished in the 2 years preceding the beginning of the enlarged emergency program.

SOURCES OF FUNDS USED DURING THE FISCAL YEAR

The combined Works Program highway and grade-crossing appropriations supplied the largest part of the funds available for the year's work, and regular Federal-aid funds were next in amount. At the beginning of the year the totals involved in current work and available for new work were as follows: Works Program grade crossings $192,780,710, Works Program highways $179,753,886, Federal aid $229,175,190, and Public Works highways $53,398,198. Of these funds $349,502,946 was allotted to work under contract and partly completed, $52,368,113 was involved in projects approved but not under contract, and $253,236,925 was available for new work. These sums include the Federal-aid authorization of $125,000,000 for the fiscal year 1937 which, after deduction of the administrative percentage, was apportioned as shown in table 1.

The total amount of all funds available for new contracts was $305,605,038.

TABLE 1.—*Apportionments of Federal aid for the fiscal years 1937 and 1938 for roads on the Federal-aid highway system, for secondary or feeder roads and for grade-crossing eliminations*

State	Federal-aid system		Secondary or feeder, 1938	Grade crossings, 1938	Total
	1937	1938			
Alabama	$2,603,967	$2,664,693	$532,939	$1,015,170	$6,816,769
Arizona	1,783,362	1,829,952	365,990	314,594	4,293,898
Arkansas	2,133,206	2,187,752	437,550	893,403	5,651,911
California	4,751,712	4,858,220	971,644	1,874,656	12,456,232
Colorado	2,286,333	2,336,054	467,211	657,357	5,746,955
Connecticut	791,660	805,426	161,085	426,784	2,184,955
Delaware	609,375	625,000	125,000	250,000	1,609,375
Florida	1,659,835	1,704,765	340,953	712,816	4,418,369
Georgia	3,168,222	3,233,279	646,656	1,223,099	8,271,256
Idaho	1,534,142	1,570,687	314,137	418,115	3,837,081
Illinois	5,165,226	5,238,798	1,047,760	2,644,980	14,096,764
Indiana	3,096,645	3,149,011	629,802	1,308,113	8,183,571
Iowa	3,234,910	3,291,322	658,264	1,410,787	8,595,283
Kansas	3,314,031	3,374,126	674,825	1,307,669	8,670,651
Kentucky	2,307,812	2,349,316	469,863	919,174	6,046,165
Louisiana	1,780,991	1,829,490	365,898	799,226	4,775,605
Maine	1,087,030	1,122,670	224,534	352,468	2,786,702
Maryland	1,025,000	1,043,938	208,787	519,993	2,797,718
Massachusetts	1,743,487	1,769,936	353,987	1,047,500	4,914,910
Michigan	3,831,476	3,893,528	778,706	1,664,807	10,168,517
Minnesota	3,426,001	3,495,178	699,036	1,342,809	8,963,024
Mississippi	2,191,112	2,247,708	449,542	806,707	5,695,069
Missouri	3,800,344	3,877,890	775,578	1,528,920	9,982,732
Montana	2,561,884	2,621,728	524,346	671,204	6,379,162
Nebraska	2,586,267	2,641,423	528,285	892,976	6,648,951
Nevada	1,593,978	1,632,385	326,477	250,000	3,802,840
New Hampshire	609,375	625,000	125,000	250,000	1,609,375
New Jersey	1,676,718	1,701,826	340,365	997,689	4,716,598
New Mexico	1,990,724	2,040,685	408,137	432,291	4,871,837
New York	6,156,604	6,258,857	1,251,771	3,424,399	17,091,631
North Carolina	2,940,809	2,998,371	599,674	1,244,662	7,783,516
North Dakota	1,958,107	1,996,414	399,283	803,068	5,156,872
Ohio	4,565,769	4,640,344	928,069	2,141,704	12,275,886
Oklahoma	2,937,406	2,995,620	599,124	1,156,175	7,688,325
Oregon	2,045,078	2,092,368	418,474	588,377	5,144,297
Pennsylvania	5,347,386	5,434,356	1,086,871	2,905,671	14,774,284
Rhode Island	609,375	625,000	125,000	250,000	1,609,375
South Carolina	1,688,441	1,722,188	344,438	752,928	4,507,995
South Dakota	2,041,872	2,084,100	416,820	694,096	5,236,888
Tennessee	2,630,111	2,681,110	536,222	958,753	6,806,196
Texas	7,771,317	7,957,610	1,591,522	2,724,825	20,045,274
Utah	1,416,208	1,447,780	289,556	322,885	3,476,429
Vermont	609,375	625,000	125,000	250,000	1,609,375
Virginia	2,280,725	2,328,369	465,674	941,656	6,016,424
Washington	1,954,781	2,002,877	400,575	767,991	5,126,224
West Virginia	1,359,961	1,390,447	278,089	671,712	3,700,209
Wisconsin	3,044,947	3,107,053	621,411	1,252,871	8,026,282
Wyoming	1,562,528	1,600,350	320,070	344,961	3,827,909
District of Columbia				250,000	250,000
Hawaii	609,375	625,000	125,000	250,000	1,609,375
Puerto Rico		625,000	125,000	369,959	1,119,959
Total	121,875,000	125,000,000	25,000,000	50,000,000	321,875,000

EMPLOYMENT ON ROAD WORK

Continuing the policy of the past 4 years, all highway work was administered with employment of those on relief rolls as a primary objective. The nine different classes of work supervised by the Bureau provided a total direct employment of 1,792,760 man-months, slightly exceeding that of the previous year but less than the peak years 1934 and 1935.

The employment by months, shown in table 2, reflects the transition from large emergency expenditures to lesser amounts of regular Federal aid. From July through October employment exceeded that for the same months in any other year with the exception of 1935. Numerous highway and grade-crossing elimination projects financed with Works Program funds were completed in the fall months and the labor released was not reemployed in the Federal highway program. By February the number employed was less than that for the same months in the years 1933 through 1936 and it remained below the 1933–36 level for the remainder of the year. However, it did not sink to the 1932 level in any month and in June the employment was more than twice that of June 1932.

TABLE 2.—*Comparison of employment during the fiscal years 1932, 1933, 1934, 1935, 1936, and 1937 on all Federal and Federal-aid highway construction and on all Federal and State road work, including State maintenance, by months*

Month	Men employed on all Federal and Federal-aid highway construction						Total men employed on all Federal and State highway construction and maintenance					
	1932	1933	1934	1935	1936	1937	1932	1933	1934	1935	1936	1937
July	164,708	81,042	129,205	335,223	191,041	249,271	385,349	305,372	332,277	549,203	375,442	435,971
August	151,418	89,346	111,211	297,224	178,756	247,841	389,949	333,403	329,813	531,034	382,846	433,533
September	116,100	122,193	115,047	247,880	143,455	227,916	356,617	374,405	337,973	498,151	340,073	414,147
October	88,869	124,106	154,016	210,079	135,660	206,113	330,104	373,246	384,029	450,322	323,374	389,966
November	62,466	129,933	185,860	201,046	118,898	172,295	289,316	371,667	420,069	426,603	290,523	353,971
December	35,991	98,271	174,358	147,101	103,493	128,314	244,971	290,465	362,031	323,700	252,229	288,248
January	29,518	75,498	154,154	96,594	82,731	76,829	229,189	266,443	315,989	240,414	202,884	210,027
February	26,673	78,215	156,814	81,257	70,418	57,844	218,218	255,256	306,090	221,406	200,451	190,336
March	28,008	95,704	144,053	90,999	86,050	69,946	211,549	279,213	296,265	217,539	227,586	200,794
April	42,205	122,256	187,657	123,063	132,834	88,361	245,843	299,882	345,278	282,740	287,478	226,286
May	59,008	139,831	271,972	167,535	193,269	122,655	259,615	330,138	466,504	331,000	374,191	299,063
June	71,772	152,276	336,414	193,263	237,330	145,375	280,636	359,605	545,013	362,339	423,466	313,149
Total (man-months)	876,736	1,308,671	2,120,761	2,191,264	1,673,935	1,792,760	3,441,356	3,839,095	4,441,331	4,434,451	3,680,543	3,755,491

While employment on highway work financed with Federal funds was decreasing most rapidly conditions indicated an improvement in general employment, particularly of semiskilled and skilled labor. A shortage of these classes of labor became evident in several sections of the country. Wages for these classes rose above the minimum prescribed in highway contracts and in a few States wages of common labor also rose above the prescribed minimum—a sure indication that contractors were bidding for services. During the last half of the year it was found unnecessary to continue the requirement that skilled and semiskilled labor be obtained through the United States employment service.

Table 3 shows the employment on the various classes of work supervised by the Bureau and that resulting from State work without Federal assistance. The greatest employment was given by Works Program highway construction, followed closely by regular Federal-aid work, with Works Program grade-crossing work ranking third. However, the grade-crossing program furnished an unknown amount of employment in addition to that shown in the table. Considerable work was done under contract by railroad forces that has not been reported.

TABLE 3.—*Direct job employment during the fiscal year 1937 on the several classes of Federal and Federal-aid road construction administered by the Bureau of Public Roads and State road construction and maintenance*

Month	Men employed on road construction—										Men employed on road maintenance by State highway departments	Total men employed
	In whole or in part with Federal funds									With State funds only, on State highways		
	National-forest highways	National-park highways	Public-lands highways	Federal-aid highways	Public Works highways	Works Program highways	Works Program grade-crossing eliminations	Loan-and-grant highways [1]	National work-relief highways			
July	2,344	5,237	250	56,097	15,967	115,923	37,352	10,730	5,371	21,744	164,956	435,971
August	2,450	6,099	167	58,800	13,969	107,321	41,905	11,481	5,649	26,810	158,882	433,533
September	2,876	5,898	134	58,874	11,574	89,298	41,776	11,902	5,584	34,459	151,772	414,147
October	2,510	5,168	52	58,511	9,886	72,655	40,775	11,425	5,131	34,136	149,717	389,966
November	1,866	4,319	7	50,490	7,576	55,945	36,045	11,053	4,994	27,988	153,688	353,971
December	1,785	2,771	----------	38,152	4,744	38,265	28,692	9,217	4,688	21,394	138,540	288,248
January	693	1,422	25	22,671	2,859	19,369	18,953	6,533	4,304	15,622	117,576	210,027
February	419	1,313	28	17,010	1,964	12,353	14,493	5,408	4,856	11,706	120,786	190,336
March	405	1,407	45	22,090	2,547	13,604	16,497	7,531	5,820	11,802	119,046	200,794
April	651	2,090	54	33,384	3,207	15,920	18,276	8,678	6,101	13,164	124,761	226,286
May	1,105	2,700	67	52,261	4,639	21,605	21,990	11,687	6,601	17,241	159,167	299,063
June	1,423	3,503	180	70,239	4,520	23,513	23,346	12,984	5,667	19,382	148,392	313,149
Total (man-months)	18,527	41,927	1,009	538,579	83,452	585,771	340,100	118,629	64,766	255,448	1,707,283	3,755,491

[1] Projects transferred by the Public Works Administration for engineering supervision.

State highway maintenance, a class of work financed entirely with State funds, required 1,707,283 man-months of labor—an amount nearly equaling the employment on work involving Federal funds. The great mileage of surfaced highways now in use requires continuous attention. In the future less work will be required in maintaining low-type surfaces inadequate for present traffic as these roads are raised to higher standards. But meanwhile additional surfaces will be constructed and the trend of maintenance expenditures and employment may be expected to continue upward.

The total employment for the year on work supervised by the Bureau—1,792,760 man-months—is the equivalent of an average full-time employment each month of 149,400 men. The number of individuals actually employed, some of them on a part-time basis, averaged approximately 209,000 persons per month. Indirect employment in the production and transportation of equipment and materials is estimated at 1.6 times the direct employment for work of the character done during the year, indicating an indirect employment of 2,868,000 man-months, and this, added to the direct employment, gives a full-time employment of 4,661,000 man-months, the equivalent of the full-time continuous employment of 388,400 men.

ROADSIDE IMPROVEMENT

The Bureau has continued to emphasize the importance of roadside improvement, urging the States to greater participation in the work. During the year 566 additional projects were included in the program at an estimated cost of $3,861,073, bringing the total number of projects to date to 1,867 as shown in table 4. This represents that portion of the work that could be definitely separated from other classes of improvements and is by no means a complete measure of what is being done. The best roadside development is much more than a planting superimposed on a completed highway. It involves also features of highway design and construction such as gentle side slopes, shallow ditches, placing topsoil on graded areas, wide shoulders, center parkways, and parking areas. Construction features important in producing safe and attractive highways are being incorporated in construction, more and more each year. Practices introduced a few years ago on outstanding roadside developments such as the Mount Vernon Memorial Highway and the Westchester Parkways in New York are now found on many newly constructed highways. The Bureau and the State highway departments are carrying on roadside improvement as an integral part of highway construction and not as a separate activity.

TABLE 4.—*Roadside improvement projects completed, under construction, and approved for construction financed with Public Works funds, Works Program funds, and Federal-aid funds, to June 30, 1937*

Funds	Projects	Total Federal funds	Estimated total cost
	Number	*Dollars*	*Dollars*
Public Works funds under acts of June 16, 1933, and June 18, 1934	982	4, 289, 243	4, 695, 707
Federal-aid funds for fiscal years 1936, 1937, and 1938	558	1, 963, 239	3, 906, 577
Works Program highway funds under act of Apr. 8, 1935	290	2, 296, 024	2, 378, 813
Works Program grade-crossing funds under act of Apr. 8, 1935	37	105, 760	108. 091
Total	1, 867	8, 654, 266	11, 089, 188

ADMINISTRATION OF HAYDEN-CARTWRIGHT ACT PENALIZING DIVERSION OF MOTOR-USER REVENUES FROM HIGHWAY PURPOSES

The Hayden-Cartwright Act of 1934 requires that any State that applies to highway purposes a lesser amount of motor-vehicle fees and gasoline taxes than was provided by law on June 18, 1934, shall be penalized not more than one-third of the Federal-aid apportionments to which it would otherwise be entitled.

Administration of this requirement is placed under the Secretary of Agriculture and has necessitated a detailed review of State laws pertaining to disposition of motor-user revenue as they existed on the date of the act and of all subsequent legislation. State officials have been required to submit at yearly intervals, certified statements showing the actual disposition made of revenues to which the act applies.

During the past year a careful review of official reports showed that motor-vehicle revenues had been diverted from highway purposes by legislative acts subsequent to 1934 in Georgia, Maryland, New Jersey, and Pennsylvania. Each of the States was notified of this finding and given an opportunity to show why a deduction in Federal-aid funds should not be made. The State Governments of Maryland and Pennsylvania restored to highway funds amounts equal to those diversions to which the act applies and it is considered that the purpose of the act has been accomplished. Georgia officials have given assurance that they will follow a similar course.

New Jersey was formally notified on April 17 of the Bureau's findings that diversion had been made requiring imposition of a penalty. The matter was called to the attention of the State highway department again in May and in June. In the absence of any responsive action by the State it became necessary to apply the penalty and the Department, by formal certificate made a reduction of $250,000 in the Federal-aid funds provided for the fiscal year 1937. This action occurred on August 7, 1937.

PREPARATION MADE FOR NEW FEDERAL-AID PROGRAMS FOR SECONDARY ROADS AND GRADE-CROSSING ELIMINATION

During the year $25,000,000 of Federal aid for secondary or feeder roads and $50,000,000 for elimination of hazards at grade crossings, authorized for the fiscal year 1938 by the act of June 16, 1936, were apportioned to the States as shown in table 1. These funds make it possible to continue, on a reduced scale, the activities first undertaken as part of the emergency program to provide employment.

Regulations to govern this work were issued in February. Administration is to be in cooperation with the State highway departments under the same general plan as has been followed in improving the Federal-aid system. The State highway departments will select projects for improvement, prepare plans, and supervise construction, all subject to the approval of the Bureau acting for the Secretary of Agriculture.

The funds for secondary roads must be matched with State funds and the States must guarantee that the roads will be satisfactorily maintained after completion. Each State is required to select a connected system of secondary roads for improvement, not exceeding 10 percent of the highway mileage, and carefully designed to connect agricultural districts with the main highway system. Selection of these systems requires much careful study of data now being collected in the highway-planning surveys. Prior to the selection and approval of such systems only those secondary roads that may reasonably be expected to form part of the system are to be approved for construction.

The grade-crossing funds are made available to the States to pay the full cost of projects without matching and the regulations stipulate that no involuntary contribution shall be required of the railroads. The funds are available for separation of rail and highway grades, relocations to avoid crossings, and for safety devices protecting traffic at crossings.

MILEAGE OF FEDERAL-AID SYSTEM

Since the Federal-aid system was originally designated as required by the Federal Highway Act of 1921 there have been numerous changes in mileage, often relatively small, but in the aggregate sufficient to require correction of the reported mileage. When the system was designated, detailed location had been made for only a small part of it and the mileages used were therefore estimates. Small corrections were necessary with almost every project. In recent years there has been much relocation of earlier construction, in almost every case shortening the distance between termini. Table 5 shows the approved mileage in the system at the end of the year.

TABLE 5.—*Designated Federal-aid highway system mileage as of June 30, 1937*

State	Mileage of approved routes outside Federal reservations	Mileage of approved routes within Federal reservations	Total mileage of system	State	Mileage of approved routes outside Federal reservations	Mileage of approved routes within Federal reservations	Total mileage of system
Alabama	3,958		3,958	New Hampshire	967	33	1,000
Arizona	1,490	580	2,070	New Jersey	1,526		1,526
Arkansas	5,028	174	5,202	New Mexico	3,274	381	3,655
California	5,592	558	6,150	New York	8,994	16	9,010
Colorado	3,354	437	3,791	North Carolina	6,746	176	6,922
Connecticut	1,046		1,046	North Dakota	7,138	84	7,222
Delaware	802		802	Ohio	7,081		7,081
Florida	2,477		2,477	Oklahoma	6,193	47	6,240
Georgia	5,629	57	5,686	Oregon	3,314	480	3,794
Idaho	2,806	589	3,395	Pennsylvania	7,630	108	7,738
Illinois	8,709	4	8,713	Rhode Island	515		515
Indiana	5,334		5,334	South Carolina	4,184		4,184
Iowa	7,652	2	7,654	South Dakota	5,795	477	6,272
Kansas	8,675	14	8,689	Tennessee	4,486	66	4,552
Kentucky	3,700	6	3,706	Texas	12,782		12,782
Louisiana	2,765		2,765	Utah	2,014	146	2,160
Maine	1,617	4	1,621	Vermont	1,036		1,036
Maryland	2,188		2,188	Virginia	4,294	48	4,342
Massachusetts	1,650		1,650	Washington	2,938	403	3,341
Michigan	5,884	48	5,932	West Virginia	2,213	29	2,242
Minnesota	7,169	165	7,334	Wisconsin	5,508	132	5,640
Mississippi	3,685	10	3,695	Wyoming	3,238	325	3,563
Missouri	7,957		7,957	Hawaii	539		539
Montana	4,656	1,081	5,737	Puerto Rico	858		858
Nebraska	5,565	20	5,585				
Nevada	1,758	21	1,779	Total	214,409	6,721	221,130

The original system was limited to 7 percent of the rural road mileage within each State. When provision has been made for improvement of 90 percent of the designated system an addition of 1 percent is permitted and further additions are permitted on the same basis. Twenty-two States have extended the system beyond the original 7 percent.

The system in any State may exceed what would otherwise be the limiting mileage by an amount equal to the mileage of the system within Federal reservations.

STATUS OF MAJOR FUNDS AND PROGRESS IN CONSTRUCTION

During the year 18,768 miles of highway were brought to completion, exclusive of work done in Federal areas and with special funds. The completed work included 10,257 miles on the Federal-aid system outside of municipalities, 1,093 miles on extensions of the system into and through municipalities, 571 miles of secondary or feeder roads in municipalities, and 6,847 miles of secondary or feeder roads outside of municipalities. Payments to the States for construction completed amounted to $337,747,071, as shown in table 6.

TABLE 6.—*Funds paid to the States during the fiscal year 1937*

State	Federal-aid authorizations for 1933 and prior years	Public Works authorizations for 1934–35	Federal-aid authorizations for 1936–38	Works Program		Total
				Highways	Grade crossings	
Alabama	$49,685	$938,056	$277,577	$2,548,150	$2,078,535	$5,892,003
Arizona		333,611	1,117,750	1,534,345	820,735	3,806,441
Arkansas	17,774	598,998	1,163,568	1,845,434	1,973,076	5,598,850
California		1,325,675	5,460,715	5,471,033	4,251,505	16,508,928
Colorado		365,775	2,114,067	1,050,860	621,073	4,151,775
Connecticut	8,621	205,398	525,297	517,481	320,931	1,577,728
Delaware		416,210	408,220	491,176	115,700	1,431,306
Florida	17,512	288,186	443,929	1,665,520	1,300,054	3,715,201
Georgia	14,739	1,383,214	1,125,486	748,757	370,954	3,643,150
Idaho	9,042	520,138	1,399,399	1,629,180	769,256	4,327,015
Illinois	36,802	3,417,962	4,415,709	6,637,067	5,709,352	20,216,892

TABLE 6.—*Funds paid to the States during the fiscal year 1937*—Continued

State	Federal-aid authorizations for 1933 and prior years	Public Works authorizations for 1934–35	Federal-aid authorizations for 1936–38	Works Program		Total
				Highways	Grade crossings	
Indiana	$4,440	$1,263,755	$2,188,548	$4,098,318	$3,441,593	$10,996,654
Iowa		358,733	2,790,273	3,653,136	3,424,817	10,226,959
Kansas		601,898	3,317,645	3,600,285	3,999,940	11,519,768
Kentucky	3,322	785,016	571,420	2,330,811	1,475,357	5,165,926
Louisiana	61,984	656,048	794,892	2,067,373	1,111,861	4,692,158
Maine		134,487	729,508	1,066,877	760,274	2,691,146
Maryland		649,634	118,327	592,867	423,527	1,784,355
Massachusetts	3,076	794,321	920,187	1,089,377	1,834,019	4,640,980
Michigan		777,639	5,220,704	2,938,184	3,729,933	12,666,460
Minnesota		646,872	3,286,330	3,880,655	3,939,522	11,753,379
Mississippi	27,420	874,897	292,930	1,910,900	1,578,714	4,684,861
Missouri		1,469,451	3,604,427	3,633,197	4,031,973	12,739,048
Montana	1,871	364,814	2,037,712	1,663,537	1,270,452	5,338,386
Nebraska		866,002	1,589,988	2,803,710	1,816,762	7,076,462
Nevada		208,220	1,227,538	978,421	486,533	2,900,712
New Hampshire		57,255	234,912	549,335	441,277	1,282,779
New Jersey	1,202	1,225,452	1,207,455	2,024,803	1,767,671	6,226,583
New Mexico		712,020	2,168,075	1,498,827	1,176,139	5,555,061
New York	51,788	2,706,316	4,114,745	7,067,809	6,381,793	20,322,451
North Carolina		1,584,100	1,989,164	2,664,566	1,852,581	8,090,411
North Dakota	46,090	1,265,982	158,637	1,903,225	1,707,599	5,081,533
Ohio	7,297	1,616,869	2,636,617	4,434,050	2,615,324	11,310,157
Oklahoma	20,037	557,186	1,850,693	3,326,722	2,212,117	7,966,755
Oregon		516,565	1,704,140	1,785,476	1,391,133	5,397,314
Pennsylvania	34,462	1,598,937	4,471,597	2,763,027	4,022,972	12,890,995
Rhode Island		71,865	314,220	965,188	292,920	1,644,193
South Carolina	5,547	818,176	952,736	1,666,895	1,123,985	4,567,339
South Dakota		972,472	576,976	1,754,421	1,432,768	4,736,637
Tennessee	3,018	621,378	1,107,726	2,129,275	930,358	4,791,755
Texas		1,226,352	6,542,014	7,940,625	7,071,153	22,780,144
Utah	21,568	171,959	1,239,439	1,097,430	773,276	3,303,672
Vermont		69,967	429,307	594,678	271,628	1,365,580
Virginia	32,319	765,098	1,683,087	2,275,018	1,436,854	6,192,376
Washington		199,749	1,730,399	1,764,612	1,907,125	5,601,885
West Virginia	5,749	776,959	446,597	1,393,412	952,208	3,574,925
Wisconsin		607,965	1,822,321	3,817,316	3,014,483	9,262,085
Wyoming	6,560	315,960	1,361,453	1,390,720	745,501	3,820,194
District of Columbia		163,350		253,538	327,303	744,191
Hawaii	6,321	517,119	219,735	494,363	253,975	1,491,513
Total	498,246	39,384,061	86,104,191	116,001,982	95,758,591	337,747,071

Details concerning the status of the various funds by States and by classes of highways are shown in tables 7 to 10. The mileages of highway according to status, by States, and by class of highway are shown in tables 11, 12, and 13. Similar information for grade-crossing work is shown in table 14. Tables 15, 16, and 17 show the mileage by types in the different stages leading up to completion. The tables are so arranged that each shows all funds or all mileage in a given status.

PROGRESS IN PUBLIC WORKS HIGHWAY CONSTRUCTION

The program of Public Works highway construction was in its last stages at the beginning of the fiscal year, and the year's work left only a small remainder of these funds for further construction. This program was financed with $400,000,000 provided by the National Recovery Act and the supplementary $200,000,000 provided by the Hayden-Cartwright Act of June 1934.

At the end of the year only $4,570,020 of these funds remained for new projects. There have been completed since the beginning of the program 35,209 miles of highway, 698 railroad-highway grade separations, 88 separations of grade between highways, and 5,908 bridges, at a cost of $575,924,780 from Public Works funds. Of the roads completed, 18,228 miles, involving $270,872,272 of the Public Works funds, are on the Federal-aid system outside of municipalities; 2,649 miles, built at a cost of $156,996,679 in Public Works funds, are on extensions of the Federal-aid system into and through municipalities; and 14,332 miles, costing $148,055,829 in Public Works funds, are secondary roads.

Of this mileage, 1,262 was completed during the last year, including 471 miles on the Federal-aid system outside of municipalities, 130 miles on extensions of the system into and through municipalities, and 661 miles of secondary roads. The

work completed during the year involved $35,206,723 of Public Works funds. Payments to the States for construction work in progress amounted to $39,384,061.

At the close of the year 344 miles of Public Works highways, to which $12,368,488 had been allotted, were under contract and largely under construction, and 61 miles had been approved for construction at an estimated cost to the Federal Government of $1,136,712 but were not yet under contract. Details concerning the funds and mileage completed, under contract, and approved for construction, classified according to the four classes of improvement and by States appear in tables 7, 8, 9, 11, 12, and 13.

PROGRESS IN FEDERAL-AID ROAD CONSTRUCTION

Improvement of the Federal-aid system was carried on with funds remaining from the previous fiscal year and under an authorization of $125,000,000 for the year 1937 provided by the Hayden-Cartwright Act of 1934. The apportionment of this fund, after deduction of the amount allowed for administrative purposes, is shown in table 1. This table also shows the apportionment of $125,000,000 Federal aid for the fiscal year 1938 made in December 1936.

During the year 7,367 miles of highway financed with $78,128,583 of Federal-aid funds were brought to completion. These projects involved $72,908,738 of State funds. Payments to the States for completed work including work done on projects still under construction amounted to $86,102,437.

At the close of the year projects under contract and in large part under construction included 8,554 miles of highway at an estimated cost of $232,174,345 to be provided as follows: $116,129,959 Federal aid, and $116,044,386 from State funds. At the same time projects had been approved, but not yet contracted for, covering 1,541 miles and involving $21,607,424 of Federal-aid funds and $22,102,067 of State funds.

On June 30, 1937, there remained available for new projects $139,883,121 of Federal-aid funds. In greater part they were funds provided for 1938. Tables 7 to 13 show the status of the work by States.

WORKS PROGRAM HIGHWAY CONSTRUCTION

Active construction on Works Program projects under an authorization of $200,000,000 began in October of the preceding fiscal year. As the fiscal year 1937 began, 8,810 miles were under contract and largely under construction involving $129,346,185; 1,112 miles involving $16,998,071 were approved but not under contract, and there was an unobligated balance available for new projects of $33,409,630.

The year's work resulted in the completion of 9,326 miles, bringing the total mileage completed in the program to 11,267. The Works Program funds involved amounted to $139,817,552. State and other Federal funds were involved to the extent of $6,936,294.

The classes of roads completed to date and the Works Program funds used to pay the cost were as follows: On the Federal-aid highway system outside of municipalities 2,501 miles costing $37,627,756 in Works Program funds; on extensions of the Federal-aid system within municipalities, 889 miles costing $27,823,366 in Works Program funds; on secondary roads within municipalities, 637 miles costing $13,517,834 in Works Program funds; and secondary roads outside of municipalities, 7,240 miles costing $60,848,596 in Works Program funds.

The 1,765 miles under contract and largely under construction were divided as follows: 224 miles on the Federal-aid system outside of municipalities, 151 miles on extensions of the Federal-aid system through municipalities, 142 miles of secondary road within municipalities, and 1,248 miles of secondary road outside of municipalities. Works Program funds involved were respectively $10,294,044, $10,291,873, $7,385,366, and $17,568,956.

Similar information for projects approved for construction but not yet under contract appears in tables 9 and 13. Details for work in all stages by States is presented in tables 7 to 13.

Funds available for new work and work approved but not yet under construction totaled $9,642,209. Very little additional highway construction can be begun with Works Program funds and by the end of the fiscal year 1938 practically all emergency highway construction will have been completed.

GRADE-CROSSING ELIMINATION AND PROTECTION PROGRAM

Grade-crossing elimination and protection work in 1937 far surpassed that of any other year. Eleven hundred and forty-nine crossings were eliminated, of which 1,086 were financed under the $200,000,000 grade-crossing program authorized by the Emergency Relief Appropriation Act of 1935. Also 196 existing grade-separation structures were reconstructed and 574 crossings were protected by signals or other safety devices.

Works Program grade-crossing eliminations completed to date number 1,152; 206 existing crossing structures have been reconstructed; and 217 crossings have been protected by signals or other devices at a total cost of $86,354,351 of which $84,836,616 was Federal funds.

The importance of the work done during the past 2 years is not to be measured so much by the number of crossings eliminated as by the volume of highway traffic protected. The current program has been characterized by the large number of crossings eliminated in and near cities at a large cost. These crossings have not been eliminated before because of hesitancy to concentrate the expenditure of large amounts of highway funds at one place. The cost per project has been higher than ever before but the number of vehicles protected per dollar of expenditure is in even higher ratio.

At the end of the year work under contract consisted of 772 crossing eliminations, 133 elimination structures being reconstructed, and 922 crossings being protected. Of the crossings being eliminated 738 were financed with Works Program grade-crossing funds. Table 14 shows details of the above work by States and also the number of projects approved but not under contract at the end of the year.

As the year closed $84,836,616 of Works Program grade-crossing funds had been expended on completed projects, $93,322,368 had been assigned to work under contract, $9,111,488 to projects approved but not then under contract, and $8,729,528 remained available for new work. Tables 7 to 10, inclusive, show the assignment of funds to the four classes of work, and table 14 shows the corresponding number of crossings to be eliminated.

The new program of elimination of hazards at grade crossings supported by $50,000,000 of Federal-aid funds for each of the fiscal years 1938 and 1939 was getting under way at the close of the year. New projects will be financed very largely with these funds. The apportionment is shown in table 1.

SUMMARY

The year's work with the funds apportioned to all States resulted in the completion of 18,768 miles of highway and the elimination of 1,149 railroad-highway grade crossings at a cost of $319,632,867 in Federal funds and $86,882,091 in State funds. The types of highway completed are shown in table 15.

The completed work was divided as follows: 10,257 miles on the Federal-aid system outside of municipalities, 1,093 miles of extensions of the system into and through municipalities, 571 miles of secondary roads in municipalities, and 6,847 miles of secondary roads outside of municipalities. Federal funds involved in the respective classes of work were $155,281,958, $59,688,908, $27,380,225 and $77,281,776.

The roads under contract at the end of the year totaled 11,274 miles and involved $268,445,582 of Federal funds, and there were 2,074 miles approved but not yet contracted for, involving $36,542,365 of Federal funds. Unobligated balances available for new work totaled $232,053,608, in large part newly apportioned funds for the fiscal year 1938. Tables 16 and 17, respectively, show the types of road under contract and the types approved but not yet under contract.

Rapid completion during the year of work financed with emergency funds greatly reduced the amount of such work in the current program and by the end of the calendar year 1937 the emergency program will have been completed with the exception of a few projects that will absorb the last remnants of these funds.

TABLE 7.—*Funds allotted to projects completed during the fiscal year 1937*

ON THE FEDERAL-AID HIGHWAY SYSTEM OUTSIDE OF MUNICIPALITIES

State	Federal aid, 1917–33	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Total Federal funds	Estimated total cost
				Highways	Grade crossings		
Alabama		$461, 209	$25, 800	$1, 399, 654	$334, 314	$2, 220, 977	$2, 329, 378
Arizona		6, 291	1, 287, 454	641, 088	471, 993	2, 406, 826	3, 097, 543
Arkansas		106, 688	65, 029	908, 767	706, 247	1, 786, 731	1, 793, 376
California		186, 635	5, 310, 414	894, 061	1, 616, 559	8, 007, 669	12, 268, 787
Colorado		12, 137	1, 709, 229		667, 577	2, 388, 943	3, 845, 734
Connecticut		5, 896	344, 518	190, 105	141, 699	682, 218	1, 044, 546
Delaware			360, 062	244, 536		604, 598	1, 001, 398
Florida	$30, 435	37, 876	355, 829	220, 198	1, 100, 898	1, 745, 236	2, 174, 277
Georgia	48, 024	768, 780	964, 469	3, 501	18, 615	1, 803, 389	2, 998, 160
Idaho	3, 207	39, 347	1, 599, 359	402, 801	611, 301	2, 656, 015	3, 881, 628
Illinois	67, 124	875, 720	3, 582, 101	2, 007, 395	2, 591, 741	9, 124, 081	13, 120, 290
Indiana	32, 852	628, 580	2, 104, 373	407, 476	984, 078	4, 157, 359	6, 694, 851
Iowa		499	3, 202, 007	740, 702	1, 106, 035	5, 049, 243	8, 502, 932
Kansas		35, 766	2, 292 794	1, 748, 383	1, 959, 057	6, 036, 000	8, 326, 868
Kentucky		167, 710	759, 606	67, 932	137, 859	1, 133, 107	1, 969, 175
Louisiana	256, 602	267, 840	795, 487	209, 400	335, 552	1, 864, 881	3, 075, 975
Maine		32, 529	722, 466	114, 661	389, 739	1, 259, 395	2, 012, 875
Maryland		537, 994		123, 202		661, 196	767, 716
Massachusetts		407, 929	166, 968	70, 007	292, 474	937, 378	1, 174, 306
Michigan		644, 563	3, 201, 270	2, 370, 284	1, 838, 191	8, 054, 308	11, 855, 461
Minnesota		57, 794	3, 274, 948	482, 259	1, 433, 834	5, 248, 835	8, 908, 285
Mississippi	68, 965	824, 271	2, 320	1, 166, 223	962, 133	3, 023, 912	3, 035, 568
Missouri		631, 049	1, 961, 777	72, 922	553, 446	3, 219, 194	5, 229, 701
Montana		427, 365	1, 995, 809	1, 010, 111	1, 303, 285	4, 736, 570	6, 539, 618
Nebraska		217, 715	1, 235, 465	1, 360, 990	1, 302, 949	4, 117, 119	5, 568, 128
Nevada		17, 592	821, 890		114, 694	954, 176	1, 109, 333
New Hampshire		1, 946	361, 381	39, 882	223, 696	626, 905	1, 015, 083
New Jersey		153, 323	1, 251, 927	554, 811	364, 464	2, 324, 525	3, 649, 124
New Mexico		56, 018	2, 148, 695	645, 039	345, 100	3, 194, 852	4, 557, 407
New York		177, 960	4, 810, 878	1, 252, 330	1, 797, 602	8, 038, 770	13, 940, 998
North Carolina		419, 189	1, 575, 701	568, 622	326, 638	2, 890, 150	4, 478, 362
North Dakota	53, 009	468, 339	192, 450	941, 275	472, 059	2, 127, 132	2, 325, 195
Ohio		296, 782	1, 687, 152	408, 562		2, 392, 496	4, 184, 199
Oklahoma		176, 212	1, 950, 121	1, 342, 957	1, 568, 663	5, 037, 953	6, 966, 559
Oregon		219, 058	1, 653, 547	519, 325	520, 512	2, 912, 442	4, 057, 002
Pennsylvania		260, 412	3, 339, 940	360, 376	1, 073, 837	5, 034, 565	8, 673, 071
Rhode Island			127, 635	490, 831	264, 253	882, 719	1, 019, 190
South Carolina		338, 157	246, 000	290, 762	579, 579	1, 454, 498	1, 849, 805
South Dakota		168, 803	777, 398	806, 295	642, 210	2, 394, 706	3, 005, 064
Tennessee	14, 300	330, 646	1, 178, 069	675, 206	219, 493	2, 417, 714	3, 762, 686
Texas		220, 435	4, 979, 648	3, 088, 629	2, 939, 136	11, 227, 848	16, 558, 118
Utah		106, 941	1, 425, 753	185, 536	160, 480	1, 878, 710	2, 560, 064
Vermont		80, 513	609, 999	165, 526	279, 659	1, 135, 697	1, 813, 558
Virginia		27, 318	1, 985, 607	229, 074	996, 679	3, 238, 678	5, 228, 189
Washington		119, 850	1, 996, 393	992, 343	541, 678	3, 650, 264	5, 576, 226
West Virginia	10, 611	72, 349	390, 447	198, 955	5, 550	677, 912	1, 074, 989
Wisconsin		275, 544	2, 101, 067	1, 180, 477	616, 808	4, 173, 896	6, 497, 071
Wyoming		13, 551	1, 437, 665	968, 137	512, 076	2, 931, 429	3, 930, 643
Hawaii		252, 457	14, 542	393, 020	98, 722	758, 741	800, 945
Total	585, 129	11, 635, 578	74, 383, 459	33, 154, 628	35, 523, 164	155, 281, 958	229, 849, 457

ON THE FEDERAL-AID HIGHWAY SYSTEM IN MUNICIPALITIES

State	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Total Federal funds	Estimated total cost
			Highways	Grade crossings		
Alabama	$354, 148		$1, 099, 083	$1, 387, 027	$2, 840, 258	$2, 866, 240
Arizona	56, 946	$56, 473	188, 076	254, 046	555, 541	641, 190
Arkansas	106, 310		257, 530	386, 108	749, 948	751, 975
California	113, 664		510, 986	1, 278, 866	1, 903, 516	2, 942, 839
Colorado			633, 864	215, 000	848, 864	904, 116
Connecticut	282, 478	38, 896	22, 784		344, 158	396, 093
Delaware	133, 489			130, 000	263, 489	264, 566
Florida	144, 119		728, 670	294, 730	1, 167, 519	1, 205, 276
Georgia	260, 647		8, 074		268, 721	335, 331
Idaho	266, 214		331, 231	114, 403	711, 848	732, 876
Illinois	720, 130	802, 707	1, 228, 036	1, 140, 972	3, 891, 845	4, 865, 579
Indiana	967, 655	134, 240	1, 266, 976	433, 010	2, 801, 881	3, 130, 074
Iowa	174, 169	276, 415	614, 611	607, 257	1, 672, 452	2, 003, 413
Kansas	45, 472	51, 386	751, 523	497, 274	1, 345, 655	1, 409, 786

TABLE 7.—*Funds allotted to projects completed during the fiscal year 1937*—Con.

ON THE FEDERAL-AID HIGHWAY SYSTEM IN MUNICIPALITIES—Continued

State	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Total Federal funds	Estimated total cost
			Highways	Grade crossings		
Kentucky	$607,105	$100,491	$403,445	$881,022	$1,992,063	$2,142,970
Louisiana	89,595	570			90,165	101,650
Maine	7,752	62,124	118,927	233,573	422,376	487,620
Maryland	231,415		112,131	81,198	424,744	479,644
Massachusetts	2,442,240			207,520	2,649,760	2,741,406
Michigan	72,566	763,244	1,087,995	772,785	2,696,590	3,672,788
Minnesota	618,596	406,967	554,758	1,088,323	2,668,644	3,168,029
Mississippi	179,817		575,018	122,637	877,472	923,987
Missouri	775,394	39,682	394,114	61,087	1,270,277	1,311,318
Montana	17,437		307,022	451,925	776,384	786,341
Nebraska	142,260	316	497,167	265,033	904,776	932,384
Nevada	65,146		7,900	62,823	135,869	142,877
New Hampshire	16,653		161,260		177,913	189,541
New Jersey	1,280,612	40,470	118,728	2,088	1,441,898	1,548,743
New Mexico	12,053		345,215	42,622	399,890	404,787
New York	775,643		3,979,997	609,200	5,364,840	5,573,024
North Carolina	73,019	5,611	404,081	962,205	1,444,916	1,485,335
North Dakota	198,843		203,660	339,633	742,136	751,395
Ohio	425,018	21,537	915,042	267,518	1,629,115	1,757,418
Oklahoma	140,756		98,406	220,016	459,178	481,490
Oregon	85,886	108,229	342,904	221,266	758,285	894,651
Pennsylvania	518,691		70,682	504,522	1,093,895	1,143,263
Rhode Island	153,832	11,708	53,463	201,684	420,687	448,540
South Carolina	153,772	900	105,346	217,954	477,972	516,773
South Dakota	535,732	8,968	451,816	116,071	1,112,587	1,123,798
Tennessee	335,116	1,317	444,623	184,471	965,527	989,598
Texas	637,741	56,630	2,299,871	1,324,094	4,318,336	4,580,312
Utah	3,000		201,566		204,566	230,720
Vermont	29,012	9,494	134,433	2,534	175,473	216,544
Virginia			289,212	697,555	986,767	1,049,851
Washington	9,880	44,026	261,090	33,449	348,445	398,429
West Virginia	361,819		161,675		523,494	593,290
Wisconsin		116,464	919,489	93,041	1,128,994	1,347,822
Wyoming	8,521	1,130	474,222	97,732	581,605	587,743
Hawaii			216,882	71,666	288,548	292,121
District of Columbia	146,775		222,251		369,026	369,026
Total	14,777,138	3,159,995	24,575,835	17,175,940	59,688,908	66,314,582

ON SECONDARY OR FEEDER ROADS IN MUNICIPALITIES

State	Works Program		Total Federal funds	Estimated total cost
	Highways	Grade crossings		
Alabama	$36,378	$857,126	$893,504	$893,858
Arizona	114,437	134,121	248,558	253,716
Arkansas	174,620	209,618	384,238	396,815
California	774,528	1,509,892	2,284,420	2,314,728
Colorado	46,418		46,418	46,966
Connecticut	96,856		96,856	97,728
Delaware	85,745		85,745	93,528
Florida	19,148	177,153	196,301	196,519
Georgia	300,056	28,356	328,412	329,714
Idaho	262,698	64,178	326,876	356,464
Illinois	543,228	1,515,034	2,058,262	2,071,237
Indiana	33,757	35,968	69,725	109,974
Iowa	187,369	141,207	328,576	336,403
Kansas	296,852	2,099	298,951	298,958
Kentucky	224,726	11,582	236,308	237,841
Louisiana	439,092		439,092	465,199
Maine	258,998		258,998	263,543
Maryland		83,683	83,683	83,683
Massachusetts	63,650	469,316	532,966	532,976
Michigan	454,520	1,314,150	1,768,670	1,851,625
Minnesota	962,677	685,460	1,648,137	1,990,285
Mississippi	35,477	38,623	74,100	74,116
Missouri	115,410	34,036	149,446	149,613
Montana	416,892	221,086	637,978	647,578
Nebraska	11,984	56,540	68,524	68,524

TABLE 7.—*Funds allotted to projects completed during the fiscal year 1937*—Con.

ON SECONDARY OR FEEDER ROADS IN MUNICIPALITIES—Continued

State	Works Program		Total Federal funds	Estimated total cost
	Highways	Grade crossings		
Nevada	$366,304	$188,392	$554,696	$582,098
New Hampshire	76,745		76,745	77,295
New Jersey		105,201	105,201	105,201
New Mexico	304,418	345,739	650,157	650,549
New York	529,321	2,099,558	2,628,879	2,665,617
North Carolina	165,075	242,517	407,592	407,610
North Dakota	118,384	532,201	650,585	651,156
Ohio	731,710	14,795	746,505	746,505
Oklahoma	599,553	189,697	789,250	801,170
Oregon	247,563		247,563	248,163
Pennsylvania	349,649	248,643	598,292	648,770
Rhode Island	185,024		185,024	235,629
South Carolina	125,630		125,630	131,175
South Dakota	8,060	33,775	41,835	41,966
Tennessee	152,762	17,022	169,784	173,915
Texas	345,339	1,738,506	2,083,845	2,194,948
Utah	342,665	17,517	360,182	461,955
Vermont	96,531	9,184	105,715	140,749
Virginia	295,655	9,567	305,222	320,042
Washington	341,781	1,010,609	1,352,390	1,454,705
West Virginia	77,771	5,750	83,521	83,521
Wisconsin	399,691	638,047	1,037,738	1,081,182
Wyoming	5,690		5,690	5,713
District of Columbia	126,636	396,804	523,440	552,704
Total	11,947,473	15,432,752	27,380,225	28,623,929

ON SECONDARY OR FEEDER ROADS OUTSIDE OF MUNICIPALITIES

State	Public Works, 1934–35 [1]	Works Program		Total Federal funds	Estimated total cost
		Highways	Grade crossings		
Alabama	$248,758	$794,741	$181,248	$1,224,747	$1,328,937
Arizona		546,915	182,852	729,767	936,560
Arkansas	68,921	831,760	153,127	1,053,808	1,054,932
California	397	3,558,072	645,466	4,203,935	4,354,920
Colorado		577,230	240,592	817,822	919,645
Connecticut	177,598	276,592		454,190	508,739
Delaware		249,904		249,904	260,775
Florida	103,402	982,696	166,921	1,253,019	1,316,837
Georgia	181,568	578,250	44,614	804,432	927,499
Idaho	160,490	1,067,341	117,174	1,345,005	1,392,007
Illinois	725,922	3,300,072	425,650	4,451,644	4,746,541
Indiana	141,028	1,233,359	366,197	1,740,584	1,899,535
Iowa	65,140	2,030,237	1,012,299	3,107,676	3,239,709
Kansas	122,064	1,197,990	315,692	1,635,746	1,660,991
Kentucky	161,045	2,003,150	32,039	2,196,234	2,394,275
Louisiana	93,677	1,039,398	214,590	1,347,665	1,499,840
Maine	29,532	691,006	226,026	946,564	966,928
Maryland	227,307	234,072	198,034	659,413	673,753
Massachusetts		90,570	262,317	352,887	360,289
Michigan	846,470	1,552,063	151,600	2,550,133	2,693,805
Minnesota	109,728	2,105,432	353,996	2,569,156	3,007,028
Mississippi	225,344	567,820	82,997	876,161	877,139
Missouri	85,293	2,837,362	174,311	3,096,966	3,137,824
Montana	182,717	945,936	259,472	1,388,125	1,422,227
Nebraska	132,648	1,062,690	136,181	1,331,519	1,361,415
Nevada	271,649	839,032	130,976	1,241,657	1,241,657
New Hampshire		294,042	118,053	412,095	437,217
New Jersey		237,207	421,503	658,710	660,034
New Mexico	40,094	291,210	101,527	432,831	549,485
New York	366,108	3,097,985	662,446	4,126,539	4,238,265
North Carolina	77,786	1,683,064	343,578	2,104,428	2,109,266
North Dakota	328,907	589,909	18,830	937,646	958,808
Ohio	561,361	1,359,128	133,370	2,053,859	2,133,124
Oklahoma	450,928	1,526,106	517,568	2,494,602	2,544,102
Oregon	76,766	926,687	446,131	1,449,584	1,449,584
Pennsylvania	588,362	1,169,388	266,233	2,023,983	2,366,619
Rhode Island		237,806	182,508	420,314	449,553
South Carolina	252,527	1,082,257	306,149	1,640,933	1,740,704

[1] Includes some secondary roads within municipalities.

TABLE 7.—*Funds allotted to projects completed during the fiscal year 1937*—Con.

ON SECONDARY OR FEEDER ROADS OUTSIDE OF MUNICIPALITIES—Continued

State	Public Works, 1934–35	Works Program		Total Federal funds	Estimated total cost
		Highways	Grade crossings		
South Dakota	$121,708	$526,195	$287,656	$935,559	$937,557
Tennessee	329,675	994,131	346,062	1,669,868	1,711,852
Texas	322,789	3,805,636	1,188,522	5,316,947	5,573,689
Utah	81,173	400,550	134,644	616,367	684,863
Vermont	2,741	326,947	71,965	401,653	453,592
Virginia	233,113	1,688,353	135,434	2,056,900	2,078,913
Washington	----------	769,175	533,478	1,302,653	1,542,209
West Virginia	287,395	516,084	68,154	871,633	896,856
Wisconsin	99,418	1,728,628	1,127,288	2,955,334	3,255,388
Wyoming	28,352	558,121	----------	586,473	587,040
Hawaii	184,106	----------	----------	184,106	184,463
Total	8,794,007	55,002,299	13,485,470	77,281,776	81,726,990

TOTAL

State	Federal aid, 1917–33	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Total Federal funds	Estimated total cost
				Highways	Grade crossings		
Alabama	----------	$1,064,116	$25,800	$3,329,855	$2,759,715	$7,179,486	$7,418,413
Arizona	----------	63,237	1,343,927	1,490,516	1,043,012	3,940,692	4,929,009
Arkansas	----------	281,920	65,029	2,172,676	1,455,100	3,974,725	3,997,098
California	----------	300,696	5,310,415	5,737,646	5,050,783	16,399,540	21,881,274
Colorado	----------	12,137	1,709,229	1,257,512	1,123,169	4,102,047	5,716,461
Connecticut	----------	465,971	383,414	586,338	141,699	1,577,422	2,047,106
Delaware	----------	133,489	360,062	580,185	130,000	1,203,736	1,620,267
Florida	$30,435	285,397	355,829	1,950,712	1,739,702	4,362,075	4,892,909
Georgia	48,024	1,210,994	964,469	889,882	91,585	3,204,954	4,590,704
Idaho	3,207	466,051	1,599,359	2,064,071	907,056	5,039,744	6,362,975
Illinois	67,124	2,321,772	4,384,808	7,078,731	5,673,397	19,525,832	24,803,647
Indiana	32,852	1,737,262	2,238,613	2,941,569	1,819,253	8,769,549	11,834,434
Iowa	----------	239,808	3,478,422	3,572,919	2,866,798	10,157,947	14,082,457
Kansas	----------	203,301	2,344,180	3,994,748	2,774,123	9,316,352	11,696,603
Kentucky	----------	935,860	860,096	2,699,253	1,062,503	5,557,712	6,744,261
Louisiana	256,601	451,112	796,058	1,687,890	550,142	3,741,803	5,142,664
Maine	----------	69,812	784,591	1,183,592	849,338	2,887,333	3,730,966
Maryland	----------	996,717	----------	469,405	362,914	1,829,036	2,004,796
Massachusetts	----------	2,850,169	166,967	224,227	1,231,628	4,472,991	4,808,977
Michigan	----------	1,563,599	3,964,514	5,464,862	4,076,726	15,069,701	20,073,679
Minnesota	----------	786,118	3,681,916	4,105,126	3,561,612	12,134,772	17,073,627
Mississippi	68,966	1,229,432	2,320	2,344,538	1,206,389	4,851,645	4,910,810
Missouri	----------	1,491,737	2,001,459	3,419,807	822,880	7,735,883	9,828,456
Montana	----------	627,518	1,995,809	2,679,962	2,235,768	7,539,057	9,395,764
Nebraska	----------	492,623	1,235,781	2,932,831	1,760,703	6,421,938	7,930,451
Nevada	----------	354,387	821,890	1,213,237	496,884	2,886,398	3,075,965
New Hampshire	----------	18,598	361,382	571,930	341,748	1,293,658	1,719,136
New Jersey	----------	1,433,935	1,292,396	910,746	893,257	4,530,334	5,963,102
New Mexico	----------	108,165	2,148,695	1,585,882	834,988	4,677,730	6,162,228
New York	----------	1,319,712	4,816,877	8,859,633	5,168,806	20,159,028	26,417,904
North Carolina	----------	569,994	1,581,312	2,820,841	1,874,939	6,847,086	8,480,573
North Dakota	53,009	996,090	192,450	1,853,227	1,362,723	4,457,499	4,686,554
Ohio	----------	1,283,161	1,708,688	3,414,442	415,684	6,821,975	8,821,246
Oklahoma	----------	767,896	1,950,121	3,567,023	2,495,943	8,780,983	10,793,321
Oregon	----------	381,709	1,761,777	2,036,479	1,187,909	5,367,874	6,649,400
Pennsylvania	----------	1,367,466	3,339,940	1,950,094	2,093,255	8,750,735	12,831,723
Rhode Island	----------	153,832	139,343	967,124	648,445	1,908,744	2,152,912
South Carolina	----------	744,457	246,900	1,603,995	1,103,681	3,699,033	4,238,457
South Dakota	----------	826,243	786,366	1,792,366	1,079,712	4,484,687	5,108,385
Tennessee	14,300	995,436	1,179,386	2,266,723	767,048	5,222,893	6,638,051
Texas	----------	1,180,966	5,036,277	9,539,474	7,190,259	22,946,976	28,907,067
Utah	----------	191,114	1,425,753	1,130,318	312,640	3,059,825	3,937,602
Vermont	----------	112,266	619,493	722,437	363,342	1,818,538	2,624,443
Virginia	----------	260,431	1,985,607	2,502,294	1,839,235	6,587,567	8,676,995
Washington	----------	129,730	2,040,419	2,364,389	2,119,214	6,653,752	8,971,569
West Virginia	10,611	721,563	390,447	954,485	79,454	2,156,560	2,648,656
Wisconsin	----------	374,962	2,217,531	4,228,285	2,475,184	9,295,962	12,181,463
Wyoming	----------	50,424	1,438,795	2,006,170	609,808	4,105,197	5,111,139
Hawaii	----------	436,563	14,542	609,901	170,389	1,231,395	1,277,529
District of Columbia	----------	146,775	----------	348,887	396,804	892,466	921,730
Total	585,129	35,206,723	77,543,454	124,680,235	81,617,326	319,632,867	406,514,958

TABLE 8.—*Funds allotted to projects under contract on June 30, 1937*

ON THE FEDERAL-AID HIGHWAY SYSTEM OUTSIDE OF MUNICIPALITIES

State	Federal aid, 1917–33	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Federal-aid grade crossings	Total Federal funds	Estimated total cost
				Highways	Grade crossings			
Alabama		$86,540	$743,501	$136,800	$60,519	$15,227	$1,042,587	$1,786,088
Arizona		6,384	1,059,403	41,478	58,378		1,165,643	1,618,219
Arkansas		41,327	3,764,816	83,113	393,352		4,282,608	4,288,565
California		23,442	4,920,656	494,584	687,131	28,119	6,153,932	10,317,531
Colorado		10,880	1,980,282	50,929	329,654	9,860	2,381,605	3,967,347
Connecticut		23,300	370,176	31,450	467,650		892,576	1,268,187
Delaware			207,664	25,446			233,110	449,740
Florida		155,464	1,138,771	299,168	219,718		1,813,121	2,952,508
Georgia		514,977	1,752,493	311,542	690,043	18,346	3,287,401	5,039,925
Idaho		44,982	1,207,499	46,379	252,800	6,271	1,557,931	2,372,659
Illinois		74,400	5,595,352	163,010	1,417,740	39,675	7,290,177	12,875,607
Indiana		61,728	3,127,183	206,433	546,929	99,300	4,041,573	7,168,875
Iowa			2,721,851	96,865	493,615		3,312,331	6,626,201
Kansas			2,965,067	188,654	701,466		3,855,187	6,873,453
Kentucky		19,313	1,457,756	193,525	537,374		2,207,968	3,765,977
Louisiana		44,459	1,625,860	332,074	1,180,936		3,183,329	11,862,095
Maine		800	829,433	69,152	359,883	5,287	1,264,555	2,094,579
Maryland			825,679	423,061	46,599	7,800	1,303,139	2,128,884
Massachusetts			2,254,006	813,690	498,041	15,710	3,581,447	6,226,225
Michigan		96,788	2,804,591	94,521	716,677		3,712,577	6,518,418
Minnesota		107,572	1,741,386	87,563	316,940	20,142	2,273,603	4,041,457
Mississippi		215,841	1,842,565	220,414	1,028,731		3,307,551	5,150,654
Missouri		120,393	4,547,564	122,484	1,463,977	22,930	6,277,348	11,314,346
Montana		7,599	2,068,684	48,463	183,319		2,308,065	3,928,458
Nebraska			2,392,298	125,713	147,912		2,665,923	5,019,496
Nevada		6,682	1,684,345	33,646	13,308		1,737,981	2,010,307
New Hampshire			180,794	46,296	100,726		327,816	512,961
New Jersey		364,695	950,684		46,580		1,361,959	2,824,242
New Mexico			2,069,478	43,071	25,879		2,138,428	3,351,240
New York		135,730	8,411,379	107,155	2,753,420		11,407,684	21,233,159
North Carolina		357,646	2,930,424	511,086	640,542		4,439,698	7,709,497
North Dakota		249,262	1,515,578	188,209	606,978		2,560,027	2,580,537
Ohio		208,475	3,919,692	945,302	2,486,343	32,120	7,591,932	11,744,568
Oklahoma	$215,209	16,154	2,297,204	142,060	537,190		3,207,817	5,709,667
Oregon		15,000	2,789,107	425,883	305,558	100,123	3,635,671	5,545,588
Pennsylvania		308,879	5,920,315	1,065,124	3,335,868		10,630,186	17,038,575
Rhode Island		2,478	754,129	3,837	12,567		773,011	1,532,061
South Carolina		111,975	2,179,723	40,530	778,749		3,110,977	6,166,174
South Dakota		88,361	1,186,440	294,337	1,079,208		2,648,346	3,582,742
Tennessee			1,039,208	464,203	414,510		1,917,921	2,957,129
Texas	52,968	153,797	7,034,766	351,313	532,398		8,125,242	15,387,949
Utah			865,061	73,933	267,435		1,206,429	1,544,297
Vermont			546,664	15,770	147,924	6,390	716,748	2,384,592
Virginia		167,466	1,542,412	63,032	344,411		2,117,321	3,776,623
Washington		25,000	1,255,312	45,393	48,790	25,610	1,400,105	2,544,604
West Virginia		187,228	949,358	336,277	899,327		2,372,190	3,387,547
Wisconsin		34,774	3,737,932	240,977	572,080	118,500	4,704,263	9,573,886
Wyoming			1,807,596	91,192	111,168		2,009,956	3,157,619
Hawaii		342,210	472,960	58,907	158,371		1,032,448	1,615,266
Total	268,177	4,432,001	109,985,097	10,294,044	29,018,714	571,410	154,569,443	267,526,324

TABLE 8.—*Funds allotted to projects under contract on June 30, 1937*—Continued

ON THE FEDERAL-AID HIGHWAY SYSTEM IN MUNICIPALITIES

State	Public Works, 1934-35	Federal aid, 1936-38	Works Program		Federal aid, grade crossings	Total Federal funds	Estimated total cost
			Highways	Grade crossings			
Alabama	$353, 477	$11, 300		$587, 846		$952, 623	$963, 923
Arizona		16, 086		3, 645		19, 731	28, 173
Arkansas	31, 616	16, 865	$275, 605	542, 392		866, 478	869, 481
California	22, 214	149, 757	216, 200			388, 171	557, 432
Colorado		80	8, 200			8, 280	8, 348
Connecticut	36, 690		60, 930			97, 620	97, 620
Delaware	7, 100		195, 870			202, 970	206, 760
Florida	134, 300	167, 070	72, 423	257, 312		631, 105	798, 518
Georgia	325, 038	113, 110	38, 510	184, 390		661, 048	774, 157
Idaho	11, 428	17, 114	6, 218	230, 986		265, 746	277, 637
Illinois	884, 007	741, 505	200	2, 513, 865		4, 139, 577	5, 050, 118
Indiana		306, 903	364, 738	1, 379, 278		2, 050, 919	2, 357, 823
Iowa	197, 432	172, 501	380, 624	1, 743, 415		2, 493, 972	2, 771, 685
Kansas		529, 724	103, 991	1, 733, 828		2, 367, 543	2, 971, 702
Kentucky	35, 261	315, 852	131, 839	524, 475		1, 007, 427	1, 372, 431
Lousiana			254, 657	289, 184		543, 841	543, 870
Maine	8, 645	34, 520	9, 000	2, 210		54, 375	88, 895
Maryland	30, 570		154, 193	3, 000		187, 763	187, 763
Massachusetts		1, 253	908, 130	440, 820		1, 350, 203	1, 351, 456
Michigan		723, 840		723, 031		1, 446, 871	2, 241, 180
Minnesota	362, 161	285, 978	52, 691	569, 269		1, 270, 099	1, 671, 256
Mississippi	7, 808	611, 065	353, 518	338, 621		1, 311, 012	1, 923, 228
Missouri	700, 723	173, 531	951, 654	1, 298, 269		3, 124, 177	3, 446, 407
Montana	40, 949	25, 032	69, 231			135, 212	154, 687
Nebraska	60, 567	67, 050	40, 466	975, 363		1, 143, 446	1, 210, 496
Nevada				3, 630		3, 630	3, 630
New Hampshire				103, 581		103, 581	103, 581
New Jersey	86, 385	10, 440	1, 595, 169	279, 000		1, 970, 994	2, 068, 999
New Mexico	1, 623		11, 239	530, 173		543, 035	546, 492
New York	593, 310	170, 930	568, 800	2, 221, 910		3, 494, 950	3, 971, 064
North Carolina	27, 324	91, 112	299, 445	384, 069		801, 950	906, 013
North Dakota	268, 311	75, 242	160, 940	293, 804		798, 297	799, 353
Ohio	33, 000		545, 780	1, 537, 245		2, 116, 025	2, 197, 370
Oklahoma	512	43, 922	153, 046	528, 818		726, 298	768, 616
Oregon	55, 000	39, 880	458, 122	695, 935	$40, 024	1, 288, 961	1, 677, 054
Pennsylvania	467, 543	147, 808	667, 640	2, 845, 450		4, 128, 441	4, 532, 685
South Carolina	63, 561	134, 370	373, 174	334, 028		905, 133	1, 149, 116
South Dakota	84, 810	15, 150	266, 940	380, 303		747, 203	766, 093
Tennessee		68, 483	231, 640	240, 920		541, 043	609, 526
Texas		104, 975		675, 764		780, 739	898, 760
Utah			56, 518	128, 441		184, 959	184, 959
Vermont			15, 110	39, 150		54, 260	63, 357
Virginia	9, 260		106, 990	646, 148		762, 398	763, 002
Washington	11, 596	67, 887		273, 855		353, 338	414, 820
West Virginia	71, 631	40, 800	151, 923	421, 932		686, 286	728, 196
Wisconsin	5, 220	379, 104	21, 900	8, 675		414, 899	846, 527
Wyoming	11, 100	6, 446	18, 609	319, 100		355, 255	359, 244
Total	5, 040, 172	5, 876, 685	10, 291, 873	27, 233, 130	40, 024	48, 481, 884	56, 283, 503

TABLE 8.—*Funds allotted to projects under contract on June 30, 1937*—Continued

ON SECONDARY OR FEEDER ROADS IN MUNICIPALITIES

State	Works Program		Federal aid, grade crossings	Total Federal funds	Estimated total cost
	Highways	Grade crossings			
Alabama	$37,300	$285,100		$322,400	$322,400
Arizona		6,095		6,095	6,095
Arkansas	25,606	672,788		698,394	699,369
California	337,937	1,083,354		1,421,291	1,519,538
Colorado		645,814		645,814	645,815
Connecticut		350,000		350,000	371,361
Delaware	742			742	742
Florida	27,540	73,500		101,040	101,040
Georgia	457,570	209,060		666,630	666,630
Idaho		192,218		192,218	192,331
Illinois	380,800	324,496		705,296	705,296
Indiana	243,625	972,814		1,216,439	1,216,439
Iowa	3,651	72,510		76,161	76,307
Kansas	21,583			21,583	21,583
Kentucky	130,745	947,119		1,077,864	1,318,444
Louisiana	289,260	338,466		627,726	660,725
Maine	63,722			63,722	63,722
Maryland	85,000	86,300		171,300	171,300
Michigan		586,600		586,600	586,600
Minnesota	332,056	576,720		908,776	1,075,642
Mississippi	33,469	51,900		85,369	85,369
Missouri	169,700	2,361,596		2,531,296	2,548,946
Montana	187,018			187,018	187,018
Nebraska	237,483	138,313		375,796	375,796
Nevada	41,438	180,124		221,562	254,788
New Hampshire	65,870	168,326		234,196	234,876
New Jersey	273,300	1,722,974		1,996,274	1,996,274
New Mexico		114,347		114,347	114,347
New York	160,400	2,601,630		2,762,030	2,762,030
North Carolina	204,228	690,250		894,478	909,978
North Dakota	13,500	824,804		838,304	838,304
Ohio	838,158	761,653		1,599,811	1,679,351
Oklahoma	262,994	260,076		523,070	523,070
Pennsylvania	1,923,921	773,914		2,697,835	3,009,424
Rhode Island		36,240		36,240	36,240
South Carolina	89,055	98,277		187,332	187,332
South Dakota	13,370	267,440		280,810	280,810
Tennessee	193,620	1,656,350		1,849,970	1,849,970
Texas	60,475	1,336,660		1,397,135	1,412,725
Utah	27,918	386,423		414,341	445,705
Virginia		74,881		74,881	74,881
Washington	142,921	402,861	$66,593	612,375	661,917
West Virginia		520,490		520,490	520,490
Wisconsin	9,391	1,371,406		1,380,797	1,381,311
Wyoming		265,400		265,400	265,400
Total	7,385,366	24,489,289	66,593	31,941,248	33,057,731

TABLE 8.—*Funds allotted to projects under contract on June 30, 1937*—Continued

ON SECONDARY OR FEEDER ROADS OUTSIDE OF MUNICIPALITIES

State	Public works, 1934–35 [1]	Works Program		Federal aid, secondary or feeder	Total Federal funds	Estimated total cost
		Highways	Grade crossings			
Alabama		$516,350	$136,750		$653,100	$653,100
Arizona	$19,573	30,137	85,665		135,375	205,881
Arkansas	44,763	96,405	143,932		285,100	285,617
California	64,220	344,459	179,396		588,075	700,990
Colorado		38,667		$7,008	45,675	52,684
Connecticut		433,340	156,370		589,710	606,311
Delaware		50,926			50,926	50,926
Florida		129,600	213,100		342,700	342,700
Georgia	243,625	627,900	322,810		1,194,335	1,194,335
Idaho	1,886		8,410	4,712	15,008	18,170
Illinois	100,455	325,626	187,861	15,716	629,658	718,854
Indiana	49,340	1,044,257	371,128		1,464,725	1,522,947
Iowa		708,507	351,987		1,060,494	1,086,534
Kansas	43,698	338,564			382,262	450,702
Kentucky	14,079	206,440	106,565		327,084	327,084
Louisiana	191,500	294,637	84,485		570,622	790,256
Maine	15,800	231,388	171,454	3,368	422,010	425,378
Maryland	123,151	85,317	387,079	3,132	598,679	601,810
Massachusetts		1,185,063	1,733,863	2,650	2,921,576	3,449,099
Michigan		202,000	171,150		373,150	374,265
Minnesota		123,628	212,071		335,699	380,866
Mississippi	157,472	300,373	137,079		594,924	608,952
Missouri	253,560	177,950	166,845	263,520	861,875	1,270,186
Montana	7,998	111,176			119,174	160,513
Nebraska	78,727	219,378	199,087		497,192	504,707
Nevada	15,297	11,110			26,407	26,407
New Hampshire		240,817	91,270		332,087	340,534
New Jersey	312,630	313,865	500,600		1,127,095	1,140,862
New Mexico	6,231	473,338			479,569	479,569
New York		622,260	581,740		1,204,000	1,204,000
North Carolina	23,682	622,541	352,270		998,493	1,036,293
North Dakota		53,820	79,830		133,650	133,650
Ohio	94,379	1,485,522	963,048	13,920	2,556,869	2,647,386
Oklahoma	215,996	235,858	373,907		825,761	825,761
Oregon	49,222	89,274	87,722	38,377	264,595	291,960
Pennsylvania	149,962	2,584,722	1,513,094		4,247,778	4,408,558
Rhode Island		2,313			2,313	2,710
South Carolina	76,476	474,118	139,716		690,310	702,522
South Dakota	14,590	187,360	174,901		376,851	376,851
Tennessee	92,741	514,344	396,190		1,003,275	1,010,418
Texas	184,531	287,262	511,112		982,905	1,005,417
Utah		254,810	91,622		346,432	346,832
Vermont		28,400	56,569		84,969	109,322
Virginia	83,980	170,063	229,009		483,052	499,340
Washington	10,000		162,141	6,008	178,149	183,961
West Virginia	142,751	748,530	98,320		989,601	1,092,600
Wisconsin		57,851	526,143	9,300	593,294	613,906
Wyoming		44,000		38,790	82,790	106,780
Hawaii	14,000	244,690	124,944		383,634	407,704
Total	2,896,315	17,568,956	12,581,235	406,501	33,453,007	35,776,210

[1] Includes some secondary roads within municipalities.

TABLE 8.—*Funds allotted to projects under contract on June 30, 1937*—Continued

TOTAL

State	Federal aid, 1917–33	Public Works, 1934–35	Federal aid, 1936–38	Works Program	
				Highways	Grade crossings
Alabama		$440,017	$754,801	$690,450	$1,070,215
Arizona		25,957	1,075,489	71,615	153,783
Arkansas		117,706	3,781,681	480,729	1,752,464
California		109,877	5,070,413	1,393,180	1,949,880
Colorado		10,880	1,930,362	97,796	975,468
Connecticut		59,990	370,176	525,720	974,020
Delaware		7,100	207,664	272,984	
Florida		289,764	1,305,841	528,731	763,630
Georgia		1,083,640	1,865,603	1,435,522	1,406,303
Idaho		58,296	1,224,613	52,597	684,414
Illinois		1,058,862	6,336,857	869,636	4,443,962
Indiana		111,068	3,434,086	1,859,053	3,270,149
Iowa		197,432	2,894,352	1,189,647	2,661,527
Kansas		43,698	3,494,790	652,793	2,435,294
Kentucky		68,652	1,773,609	662,549	2,115,533
Louisiana		235,959	1,625,860	1,170,628	1,893,071
Maine		25,244	863,953	373,262	533,548
Maryland		153,721	825,679	747,571	522,978
Massachusetts			2,255,259	2,906,883	2,672,724
Michigan		96,788	3,528,431	296,521	2,197,458
Minnesota		469,733	2,027,364	595,938	1,675,000
Mississippi		381,120	2,453,630	907,775	1,556,331
Missouri		1,074,675	4,721,095	1,421,788	5,290,688
Montana		56,546	2,093,716	415,888	183,319
Nebraska		139,295	2,459,348	623,040	1,460,674
Nevada		21,979	1,684,345	86,194	197,062
New Hampshire			180,794	352,983	463,903
New Jersey		763,710	961,124	2,182,334	2,549,154
New Mexico		7,854	2,069,477	527,648	670,400
New York		729,041	8,582,308	1,398,615	8,158,700
North Carolina		408,651	3,021,537	1,637,300	2,067,131
North Dakota		517,574	1,590,820	416,469	1,805,415
Ohio		335,854	3,919,692	3,814,762	5,748,289
Oklahoma	$215,209	232,663	2,341,125	793,958	1,699,991
Oregon		119,222	2,823,987	973,279	1,089,215
Pennsylvania		926,384	6,068,123	6,241,407	8,468,326
Rhode Island		2,478	754,129	6,150	48,807
South Carolina		252,012	2,314,093	976,877	1,350,770
South Dakota		187,761	1,201,590	762,007	1,901,852
Tennessee		92,740	1,107,691	1,403,808	2,707,970
Texas	52,968	338,328	7,139,741	699,049	3,055,935
Utah			865,031	413,179	873,921
Vermont			546,664	59,279	243,644
Virginia		260,706	1,542,412	340,086	1,294,448
Washington		46,596	1,323,200	188,313	887,647
West Virginia		401,611	990,158	1,236,729	1,940,069
Wisconsin		39,994	4,117,036	330,119	2,478,304
Wyoming		11,100	1,814,042	153,801	695,668
Hawaii		356,210	472,961	303,597	283,314
Total	268,177	12,868,488	115,861,782	45,540,239	93,322,368

TABLE 8.—*Funds allotted to projects under contract on June 30, 1937*—Continued

TOTAL—Continued

State	Federal aid, secondary or feeder	Federal aid, grade crossings	Total Federal funds	Estimated total cost
Alabama		$15,227	$2,970,710	$3,725,511
Arizona			1,326,844	1,858,368
Arkansas			6,132,580	6,143,032
California		28,119	8,551,469	13,095,491
Colorado	$7,008	9,860	3,081,374	4,674,194
Connecticut			1,929,906	2,343,479
Delaware			487,748	708,168
Florida			2,887,966	4,194,766
Georgia		18,346	5,809,414	7,675,047
Idaho	4,712	6,271	2,030,903	2,860,797
Illinois	15,716	39,675	12,764,708	19,349,875
Indiana		99,300	8,773,656	12,266,084
Iowa			6,942,958	10,560,727
Kansas			6,626,575	10,317,440
Kentucky			4,620,343	6,783,936
Louisiana			4,925,518	13,856,946
Maine	3,368	5,287	1,804,662	2,672,574
Maryland	3,132	7,800	2,230,881	3,089,757
Massachusetts	2,650	15,710	7,853,226	11,026,780
Michigan			6,119,198	9,720,463
Minnesota		20,142	4,788,177	7,169,221
Mississippi			5,298,856	7,768,203
Missouri	263,520	22,930	12,794,696	18,579,885
Montana			2,749,469	4,430,676
Nebraska			4,682,357	7,110,495
Nevada			1,989,580	2,295,132
New Hampshire			997,680	1,191,952
New Jersey			6,456,322	8,030,377
New Mexico			3,275,379	4,491,648
New York			18,868,664	29,170,253
North Carolina			7,134,619	10,561,781
North Dakota			4,330,278	4,351,844
Ohio	13,920	32,120	13,864,637	18,268,675
Oklahoma			5,282,946	7,827,114
Oregon	38,377	140,147	5,189,227	7,514,602
Pennsylvania			21,704,240	28,989,242
Rhode Island			811,564	1,571,011
South Carolina			4,893,752	8,205,144
South Dakota			4,053,210	5,006,496
Tennessee			5,312,209	6,427,043
Texas			11,286,021	18,704,851
Utah			2,152,161	2,521,793
Vermont		6,390	855,977	2,557,271
Virginia			3,437,652	5,113,846
Washington	6,008	92,203	2,543,967	3,805,302
West Virginia			4,568,567	5,728,833
Wisconsin	9,300	118,500	7,093,253	12,415,630
Wyoming	38,790		2,713,401	3,889,043
Hawaii			1,416,082	2,022,970
Total	406,501	678,027	268,445,582	392,643,768

TABLE 9.—*Funds allotted to projects approved but not under contract on June 30, 1937*

ON THE FEDERAL-AID HIGHWAY SYSTEM OUTSIDE OF MUNICIPALITIES

State	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Federal aid, grade crossings	Total Federal funds	Estimated total cost
			Highways	Grade crossings			
Alabama		$1,802,550				$1,802,550	$3,605,100
Arizona		207,931				207,931	497,075
Arkansas		71,694				71,694	72,022
California		480,555				480,555	892,993
Colorado		51,102				51,102	92,912
Connecticut	$108,613	54,743	$9,750			173,106	439,490
Delaware		159,648	3,705	$277,993	$79,118	520,464	684,156
Florida		58,000				58,000	116,000
Georgia		618,226	259,590	173,210		1,051,026	1,669,251
Idaho		204,250				204,250	343,441
Illinois		1,047,096				1,047,096	2,094,193
Indiana		595,136				595,136	1,190,272
Iowa		297,300	28,300			325,600	646,114
Kansas		461,177				461,177	922,361
Kentucky		594,577				594,577	1,188,934
Louisiana		200,455		114,180		314,635	578,274
Maine		296,205		19,688		315,893	659,771
Maryland	21,000	233,000	44,106	384,535		682,641	915,642
Massachusetts		240,420	58,370			298,790	586,280
Michigan		996,572				996,572	1,993,145
Minnesota		85,689				85,689	205,332
Mississippi		380,100				380,100	761,000
Missouri		966,717				966,717	2,432,325
Montana		558,186	8,462			566,648	1,110,943
Nebraska		783,722	5,420	66,218		855,360	1,701,118
Nevada		541,595				541,595	624,534
New Hampshire		100,369				100,369	203,068
New Jersey		9,275	4,720	145,895		159,890	211,560
New Mexico	45,034	157,936		11,202		214,172	375,858
New York		1,602,175	3,478	72,000		1,677,653	3,327,028
North Carolina	11,170	223,641				234,811	501,043
North Dakota		183,572	14,700			198,272	198,272
Ohio		1,235,890				1,235,890	2,471,780
Oklahoma		344,189		171,000		515,189	865,222
Oregon		21,129			22,618	43,747	90,829
Pennsylvania		1,049,598	11,000	495,410		1,556,008	2,632,969
Rhode Island		53,823				53,823	107,790
South Carolina		225,200		76,360		301,560	736,860
South Dakota		85,990				85,990	149,987
Tennessee		140,140				140,140	280,280
Texas		197,453				197,453	395,480
Utah		98,500				98,500	150,830
Vermont		264,064				264,064	646,048
Virginia		217,156		56,860		274,016	491,172
Washington		299,400				299,400	579,034
West Virginia		203,690		114,783	10,075	328,548	539,937
Wisconsin		256,500				256,500	583,068
Wyoming		132,060				132,060	214,320
Hawaii	26,049	129,665				155,714	294,390
Total	211,866	19,218,061	451,601	2,179,334	111,811	22,172,673	42,069,503

TABLE 9.—*Funds allotted to projects approved but not under contract on June 30, 1937*—Continued

ON THE FEDERAL-AID HIGHWAY SYSTEM IN MUNICIPALITIES

State	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Federal aid, grade crossings	Total Federal funds	Estimated total cost
			Highways	Grade crossings			
Alabama		$134,925				$134,925	$269,860
Arizona		35,364				35,364	4,9111
California		111,892		$311,709		423,601	522,749
Connecticut		34,880	$124,660			159,540	194,430
Delaware		8,689				8,689	17,378
Georgia	$84,072	91,690	373,364	2,710		551,836	643,526
Idaho	13,188					13,188	38,731
Illinois		46,471				46,471	92,942
Indiana		51,634				51,634	103,268
Iowa		97,350	36,900	65,090		199,340	316,911
Kansas		36,669				36,669	73,338
Kentucky		37,987	53,722	274,086		365,795	403,782
Louisiana				103,980		103,980	288,180
Maine		9,187				9,187	18,374
Maryland	209,600					209,600	213,950
Massachusetts	91,944		1,880	249,991		343,815	343,815
Michigan	40,000	287,753	39,582	43,500		410,835	752,206
Minnesota		13,241				13,241	106,148
Mississippi	7,083	25,000	8,900			40,983	66,183
Missouri		70,027				70,027	155,715
Montana		17,823				17,823	31,691
Nebraska		13,908	251,596			265,504	279,412
Nevada		64,056				64,056	73,869
New Jersey	88,802	234,090	4,560			327,452	1,024,329
New York	11,400	272,520				283,920	556,440
North Carolina	26,400	6,545				32,945	39,490
North Dakota		3,970	236,331			240,301	240,301
Ohio		17,940		246,124		264,064	287,819
Oklahoma		63,573	5,000	230,000		298,573	379,780
Oregon		5,189			$65,873	71,062	74,376
Pennsylvania			115,080			115,080	199,126
South Carolina	55,613	17,900				73,513	123,523
South Dakota			7,548			7,548	7,548
Tennessee		13,400		71,400		84,800	98,200
Texas	1,951	12,470	68,041			82,462	169,480
Utah		76,000				76,000	113,970
Virginia	26,444	144,755	23,636	318,590		513,425	659,381
Washington		168,500				168,500	319,712
West Virginia		24,865		277,600		302,465	327,330
Wisconsin		139,100				139,100	281,933
Total	656,497	2,389,363	1,350,800	2,194,780	65,873	6,657,313	9,958,307

ON SECONDARY OR FEEDER ROADS IN MUNICIPALITIES

State	Works Program		Federal aid, secondary or feeder	Federal aid, grade crossings	Total Federal funds	Estimated total cost
	Highways	Grade crossings				
Georgia	$125,740	$131,350			$257,090	$257,090
Idaho			$11,028		11,028	22,057
Illinois	3,500				3,500	3,500
Indiana				$117,790	117,790	117,790
Kentucky	20,052	157,000			177,052	190,644
Louisiana		128,059			128,059	128,964
Missouri			3,280		3,280	7,640
Montana		80,744			80,744	134,423
New Jersey		44,730			44,730	44,730
Ohio	71,000	1,588,876			1,659,876	1,952,551
Oklahoma	35,690	120,000			155,690	175,740
Pennsylvania	409,089	313,301			722,390	902,469
South Carolina		26,000			26,000	26,000
South Dakota		9,260			9,260	9,260
Tennessee	16,980				16,980	16,980
Virginia	29,620				29,620	29,620
West Virginia		184,540			184,540	184,540
Total	711,671	2,783,860	14,308	117,790	3,627,629	4,203,998

TABLE 9.—*Funds allotted to projects approved but not under contract on June 30, 1937*—Continued

ON SECONDARY OR FEEDER ROADS OUTSIDE OF MUNICIPALITIES

State	Public Works, 1934–35 [1]	Works Program		Federal aid, secondary or feeder	Total Federal funds	Estimated total cost
		Highways	Grade crossings			
Alabama	$2,184		$83,900		$86,084	$86,183
Colorado			24,765		24,765	55,910
Connecticut		$118,039	280,190		398,229	488,170
Georgia	66,900	466,322	108,930	$9,699	651,851	661,550
Idaho			55,933	47,198	103,131	150,327
Illinois	39,700	12,500			52,200	58,300
Kansas		35,840			35,840	35,840
Kentucky			18,570	126,792	145,362	350,191
Louisiana			195,606		195,606	213,410
Maryland	69,000	115,196	454,000		638,196	773,195
Minnesota				10,485	10,485	20,970
Missouri				121,200	121,200	323,340
Montana	7,598				7,598	74,988
Nebraska	3,321	660			3,981	31,126
New Jersey			350,790		350,790	371,190
New York				167,500	167,500	335,000
North Carolina	3,967				3,967	5,540
North Dakota		85,790			85,790	85,790
Ohio	45,000	72,220			117,220	129,470
Oklahoma		24,000	50,000		74,000	193,600
Oregon			51,387	13,380	64,767	73,310
Pennsylvania		156,282			156,282	170,922
South Carolina	217				217	33,200
South Dakota	3,862	19,090	201,133		224,085	284,440
Tennessee	10,431	123,510			133,941	136,427
Texas	500	37,587			38,087	97,094
Utah		59,400			59,400	59,400
Virginia			78,310		78,310	78,310
West Virginia		40,197			40,197	43,200
Wyoming	15,669				15,669	33,500
Total	268,349	1,366,633	1,953,514	496,254	4,084,750	5,453,893

[1] Includes some secondary roads within municipalities.

TOTAL

State	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Federal aid, secondary or feeder	Federal aid, grade crossings	Total Federal funds	Estimated total cost
			Highways	Grade crossings				
Alabama	$2,184	$1,937,475		$83,900			$2,023,559	$3,961,143
Arizona		243,295					243,295	546,186
Arkansas		71,694					71,694	72,022
California		592,447		311,709			904,156	1,415,742
Colorado		51,102		24,765			75,867	148,822
Connecticut	108,613	89,623	$252,449	280,190			730,875	1,122,090
Delaware		168,337	3,705	277,993		$79,118	529,153	701,534
Florida		58,000					58,000	116,000
Georgia	150,972	709,916	1,225,016	416,200	$9,699		2,511,803	3,231,417
Idaho	13,188	204,250		55,933	58,226		331,597	554,556
Illinois	39,700	1,093,567	16,000				1,149,267	2,248,935
Indiana		646,770				117,790	764,560	1,411,330
Iowa		394,650	65,200	65,090			524,940	963,025
Kansas		497,846	35,840				533,686	1,031,539
Kentucky		632,564	73,774	449,656	126,792		1,282,786	2,133,551
Louisiana		200,455		541,825			742,280	1,208,828
Maine		305,392		19,688			325,080	678,145
Maryland	299,600	233,000	159,302	838,535			1,530,437	1,902,787
Massachusetts	91,944	240,420	60,250	249,991			642,605	930,095
Michigan	40,000	1,284,325	39,582	43,500			1,407,407	2,745,351
Minnesota		98,930			10,485		109,415	332,450
Mississippi	7,083	405,100	8,900				421,083	827,183
Missouri		1,036,744			124,480		1,161,224	2,919,020
Montana	7,598	576,009	8,462	80,744			672,813	1,352,045
Nebraska	3,321	797,630	257,676	66,218			1,124,845	2,011,656
Nevada		605,651					605,651	698,403
New Hampshire		100,369					100,369	203,068
New Jersey	88,801	243,365	9,280	541,416			882,862	1,651,809
New Mexico	45,034	157,936		11,202			214,172	375,858

TABLE 9.—*Funds allotted to projects approved but not under contract on June 30, 1937*—Continued

TOTAL—Continued

State	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Federal aid, secondary or feeder	Federal aid, grade crossings	Total Federal funds	Estimated total cost
			Highways	Grade crossings				
New York	$11,400	$1,874,695	$3,478	$72,000	$167,500		$2,129,073	$4,218,468
North Carolina	41,537	230,186					271,723	546,073
North Dakota		187,542	336,821				524,363	524,363
Ohio	45,000	1,253,830	143,220	1,835,000			3,277,050	4,841,620
Oklahoma		407,762	64,690	571,000			1,043,452	1,614,342
Oregon		26,318		51,387	13,380	$88,491	179,576	238,515
Pennsylvania		1,049,598	691,451	808,711			2,549,760	3,905,486
Rhode Island		53,823					53,823	107,790
South Carolina	55,830	243,100		102,360			401,290	919,583
South Dakota	3,863	85,990	26,638	210,392			326,883	451,235
Tennessee	10,431	153,540	140,490	71,400			375,861	531,887
Texas	2,451	209,923	105,628				318,002	662,054
Utah		174,500	59,400				233,900	324,200
Vermont		264,064					264,064	646,048
Virginia	26,444	361,911	53,256	453,760			895,371	1,258,483
Washington		467,900					467,900	898,746
West Virginia		228,555	40,197	576,923		10,075	855,750	1,095,007
Wisconsin		395,600					395,600	865,001
Wyoming	15,669	132,060					147,729	247,820
Hawaii	26,049	129,665					155,714	294,390
Total	1,136,712	21,607,424	3,880,705	9,111,488	510,562	295,474	36,542,365	61,685,701

TABLE 10.—*Unobligated balances of funds available for allotment to new projects on June 30, 1937*

State	Public Works authorizations for 1934–35	Federal-aid authorizations for 1936–38	Works Program		Federal aid, secondary or feeder	Federal aid, grade crossings	Total
			Highways	Grade crossings			
Alabama	$80,362	$5,154,905	$130,810	$111,662	$532,939	$999,943	$7,010,621
Arizona	19,217	1,965,754	80,678	11,892	365,990	314,594	2,758,125
Arkansas	8,802	2,545,277	41,761	22,287	437,550	893,403	3,949,080
California	81,075	3,231,610	6,144	123	971,644	1,846,537	6,137,133
Colorado	10,087	2,331,756	1,472,138	339,301	460,203	647,497	5,260,982
Connecticut	37,718	1,545,126	50,208	316,775	161,085	426,784	2,537,696
Delaware	429	1,107,687	43,436	10,246	125,000	170,882	1,457,680
Florida	13,459	3,047,060	53,881	309,062	340,953	712,816	4,477,231
Georgia	1,158,809	5,893,503	1,388,909	2,981,861	636,957	1,204,753	13,264,792
Idaho	17,508	1,536,983	22,169	27,076	251,199	411,844	2,266,779
Illinois	148,473	3,419,284	118,672	189,825	1,032,044	2,605,305	7,513,603
Indiana	130,112	2,265,198	6,745	21,694	629,802	1,091,023	4,144,574
Iowa		2,805,349	1,449	264	658,264	1,410,787	4,876,113
Kansas	21,806	3,483,904	27,476	36,841	674,825	1,307,669	5,552,521
Kentucky	32,192	3,134,737	53,315	29,406	343,071	919,174	4,511,895
Louisiana	105,720	2,465,995	31,912	228,428	365,898	799,226	3,997,179
Maine	6,191	1,109,373	196	24,288	221,166	347,181	1,708,395
Maryland	336,983	2,036,129	374,460	337,323	205,655	512,193	3,802,743
Massachusetts	165,515	2,592,653	71,525	56,490	351,337	1,031,790	4,269,310
Michigan	19,526	1,881,877	22,949	113	778,706	1,664,807	4,367,978
Minnesota	177,239	3,895,364		4,560	688,551	1,322,667	6,088,381
Mississippi	88,422	3,774,294	87,417	478,754	449,542	806,707	5,685,136
Missouri	145,371	3,011,058	107,598	28,585	387,578	1,505,990	5,186,180
Montana	64,179	2,759,860	9,002	153	524,346	671,204	4,028,744
Nebraska	19,396	2,860,787	12,326	120,345	528,285	892,976	4,434,115
Nevada	9,979	1,079,398	250	7,561	326,477	250,000	1,673,665
New Hampshire	19,140	1,151,286	4,766	16,833	125,000	250,000	1,567,025
New Jersey	100,007	2,513,349	27,445		340,365	997,689	3,978,855
New Mexico	15,893	1,235,969	33,517	5,367	408,137	432,291	2,131,174
New York	202,480	3,271,785	380,818	177,683	1,084,271	3,424,399	8,541,436
North Carolina	38,469	3,798,638	52,532	812,335	599,674	1,244,662	6,546,310
North Dakota	270,783	3,943,871	14,420		399,283	803,068	5,431,425
Ohio	78,816	6,889,338	116,861	440,925	914,149	2,109,584	10,549,673
Oklahoma	25,005	3,921,459	5,925	18,010	599,124	1,156,175	5,725,698
Oregon	78,082	1,389,605	11,771	5,693	366,717	359,739	2,211,607
Pennsylvania	44,086	5,579,729	344,308	102,505	1,086,871	2,905,671	10,063,170
Rhode Island		896,455		2,439	125,000	250,000	1,273,894
South Carolina	70,992	2,299,432	51,563	503,145	344,438	752,928	4,022,498
South Dakota	50,070	4,088,801	13,638	5,356	416,820	694,096	5,268,781

TABLE 10.—*Unobligated balances of funds available for allotment to new projects on June 30, 1937*—Continued

State	Public Works authorizations for 1934–35	Federal-aid authorizations for 1936–38	Works Program		Federal aid, secondary or feeder	Federal aid, grade crossings	Total
			Highways	Grade crossings			
Tennessee	$1,856	$5,254,798	$151,146	$357,561	$536,222	$958,753	$7,260,336
Texas	62,621	8,950,567	45,429	383,402	1,591,522	2,724,825	13,758,366
Utah		1,546,191	34,149	14,444	289,556	322,885	2,207,225
Vermont	121	395,960	4,858		125,000	243,610	769,549
Virginia	210,759	2,922,542	198,414	82,903	465,674	941,656	4,821,948
Washington	43,325	1,634,336	30,836	10,476	394,566	675,788	2,789,327
West Virginia	212,238	2,457,002		81,492	278,089	661,637	3,690,458
Wisconsin	45,094	2,350,186	8,210	44	612,111	1,134,371	4,150,016
Wyoming	73,115	605,318	2,937		281,280	344,961	1,307,611
District of Columbia				14,000		250,000	264,000
Hawaii	28,498	1,226,583	12,535		125,000	250,000	1,642,616
Puerto Rico		625,000			125,000	369,959	1,119,959
Total	4,570,020	139,883,121	5,761,504	8,729,528	24,082,936	49,026,499	232,053,608

TABLE 11.—*Mileage of projects completed during the fiscal year 1937*

ON THE FEDERAL-AID HIGHWAY SYSTEM OUTSIDE OF MUNICIPALITIES

State	Federal aid, 1917–33	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Total
				Highways	Grade crossings	
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Alabama		22.6	9.0	57.0	1.6	90.2
Arizona			80.1	54.3	11.5	145.9
Arkansas		8.8	2.0	75.5	29.8	116.1
California		1.1	262.4	29.9	5.6	299.0
Colorado			120.1		11.4	131.5
Connecticut			13.2	.3	.6	14.1
Delaware			33.0	9.9		42.9
Florida	6.5	.9	22.4	7.5	5.9	43.2
Georgia		49.8	122.6	.3	.2	172.9
Idaho	2.5	1.0	237.5	34.8	8.4	284.2
Illinois	9.6	9.0	107.7	87.1	7.7	221.1
Indiana	5.3	25.9	139.9	15.5	3.5	190.1
Iowa			371.4	37.0	18.8	427.2
Kansas		2.7	655.2	154.2	15.7	827.8
Kentucky		6.0	96.6	10.5	1.8	114.9
Louisiana	.4	18.9	58.2	1.0	1.2	79.7
Maine		.4	48.0	2.7	4.9	56.0
Maryland		15.0		1.6		16.6
Massachusetts		2.1	3.1	.5	1.0	6.7
Michigan		31.6	274.6	127.6	26.2	460.0
Minnesota		6.0	456.7	40.9	40.7	544.3
Mississippi		32.9		67.0	36.0	135.9
Missouri		10.6	250.4	4.9	4.0	269.9
Montana		10.6	280.6	68.6	16.3	376.1
Nebraska		20.0	177.5	135.6	80.5	413.6
Nevada			151.3		.8	152.1
New Hampshire			22.8	1.8	1.0	25.6
New Jersey		4.0	37.9	7.5	1.0	50.4
New Mexico		6.0	271.6	30.5	13.9	322.0
New York		11.0	190.0	11.6	4.7	217.3
North Carolina		17.9	341.1	32.7	3.6	395.3
North Dakota		54.4	.4	119.5	30.1	204.4
Ohio		5.4	54.9	6.3		66.6
Oklahoma		2.2	136.2	100.5	21.1	260.0
Oregon		4.9	106.6	13.5	1.3	126.3
Pennsylvania		8.8	114.3	8.4	7.4	138.9
Rhode Island			3.7	5.9	.8	10.4
South Carolina		7.6	53.3	48.9	3.9	113.7
South Dakota		38.5	188.7	125.8	33.3	386.3
Tennessee		3.1	97.2	30.4	5.7	136.4
Texas		5.6	602.8	224.5	50.3	883.2
Utah		.3	137.9	47.7	.3	186.2
Vermont		1.7	59.7	4.2	1.2	66.8
Virginia		6.3	180.1	10.9	7.8	205.1
Washington		.3	154.1	50.1	7.2	211.7
West Virginia		4.6	39.3	11.8		55.7
Wisconsin		8.6	164.5	59.2	5.7	238.0
Wyoming		1.2	262.6	48.6	3.1	315.5
Hawaii		2.3	.8	5.4	.5	9.0
Total	24.3	470.6	7,194.0	2,029.9	538.0	10,256.8

TABLE 11.—*Mileage of projects completed during the fiscal year 1937*—Con.

ON THE FEDERAL-AID HIGHWAY SYSTEM IN MUNICIPALITIES

State	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Total
			Highways	Grade crossings	
	Miles	*Miles*	*Miles*	*Miles*	*Miles*
Alabama	5.4		12.6	3.9	21.9
Arizona	.6	0.9	9.7	.5	11.7
Arkansas	2.0		20.6	2.8	25.4
California	.9		3.7	1.1	5.7
Colorado			18.0	.4	18.4
Connecticut	2.7	1.0	.2		3.9
Delaware	.6			.3	.9
Florida	1.6		9.5	1.1	12.2
Georgia	10.5		1.0		11.5
Idaho	.6		28.0	.7	29.3
Illinois	3.3	19.8	21.5	2.5	47.1
Indiana	13.8	10.8	24.3	1.1	50.0
Iowa	.5	21.9	14.9	3.5	40.8
Kansas	1.2	10.5	8.8	2.3	22.8
Kentucky	3.8	4.2	8.3	1.6	17.9
Louisiana	.8				.8
Maine		2.2	3.8	.1	6.1
Maryland	1.1		3.1	.1	4.3
Massachusetts	1.0			.3	1.3
Michigan	1.2	12.3	38.3	1.1	52.9
Minnesota	3.2	39.3	16.1	8.7	67.3
Mississippi	6.0		23.8	4.7	34.5
Missouri	2.6	3.6	7.1	.4	13.7
Montana	.1		6.1	.2	6.4
Nebraska	2.8	.1	50.9	6.4	60.2
Nevada	.7		.2		.9
New Hampshire	.6		2.5		3.1
New Jersey	3.4	.4	2.2		6.0
New Mexico	.9		37.4	.5	38.8
New York	3.1		21.6	1.0	25.7
North Carolina	.3	.4	8.9	3.1	12.7
North Dakota	9.7		20.3	1.8	31.8
Ohio	3.8	.3	9.1	.1	13.3
Oklahoma	1.2		3.9	.7	5.8
Oregon	.2	4.3	12.9	.3	17.7
Pennsylvania	2.0		.8	.4	3.2
Rhode Island	1.1	.3	.9	.2	2.5
South Carolina	2.0	.5	8.7	1.3	12.5
South Dakota	21.0	1.7	74.0	1.8	98.5
Tennessee	1.6		10.7	.7	13.0
Texas	5.0	1.8	113.8	6.4	127.0
Utah			16.4		16.4
Vermont	1.4	.7	1.6		3.7
Virginia			9.4	1.7	11.1
Washington	.3	2.6	2.7	.3	5.9
West Virginia	3.7		3.6		7.3
Wisconsin		8.2	24.3	.9	33.4
Wyoming	.2	.5	27.0	.6	28.3
Hawaii			3.5	.2	3.7
District of Columbia	1.6		2.4		4.0
Total	130.1	148.3	749.1	65.8	1,093.3

TABLE 11.—*Mileage of projects completed during the fiscal year 1937*—Continued

ON SECONDARY OR FEEDER ROADS IN MUNICIPALITIES

State	Works Program		Total	State	Works Program		Total
	Highways	Grade crossings			Highways	Grade crossings	
	Miles	*Miles*	*Miles*		*Miles*	*Miles*	*Miles*
Alabama	1.3	3.0	4.3	Nevada	9.4	0.3	9.7
Arizona	14.4	.4	14.8	New Hampshire	2.1		2.1
Arkansas	10.3	.8	11.1	New Jersey		.2	.2
California	39.9	1.7	41.6	New Mexico	16.7	.3	17.0
Colorado	1.5		1.5	New York	6.0	1.3	7.3
Connecticut	2.1		2.1	North Carolina	9.1	1.1	10.2
Delaware	1.8		1.8	North Dakota	9.2	.8	10.0
Florida	1.2	.9	2.1	Ohio	6.9		6.9
Georgia	17.0	.1	17.1	Oklahoma	41.2	1.1	42.3
Idaho	27.5	.4	27.9	Oregon	13.2		13.2
Illinois	18.3	2.7	21.0	Pennsylvania	9.8	1.1	10.9
Indiana	2.3	.9	3.2	Rhode Island	1.9		1.9
Iowa	10.6	2.3	12.9	South Carolina	12.5		12.5
Kansas	7.9		7.9	South Dakota	.9	.1	1.0
Kentucky	4.7		4.7	Tennessee	6.6		6.6
Louisiana	7.8		7.8	Texas	35.7	4.4	40.1
Maine	9.3		9.3	Utah	37.4	.4	37.8
Maryland		.1	.1	Vermont	.8	.3	1.1
Massachusetts	.6	.2	.8	Virginia	7.9		7.9
Michigan	16.7	.7	17.4	Washington	13.3	1.6	14.9
Minnesota	45.3	3.6	48.9	West Virginia	2.9		2.9
Mississippi	1.7	1.4	3.1	Wisconsin	36.1	1.7	37.8
Missouri	3.0	.4	3.4	Wyoming	.2		.2
Montana	7.8	.6	8.4	District of Columbia	1.2	.2	1.4
Nebraska	1.4	.2	1.6				
				Total	535.4	35.3	570.7

ON SECONDARY OR FEEDER ROADS OUTSIDE OF MUNICIPALITIES

State	Public Works 1934–35[1]	Works Program		Total	State	Public Works 1934–35[1]	Works Program		Total
		High-ways	Grade cross-ings				High-ways	Grade cross-ings	
	Miles	*Miles*	*Miles*	*Miles*		*Miles*	*Miles*	*Miles*	*Miles*
Alabama	6.4	40.5	1.8	48.7	New Hampshire		19.0	0.7	19.7
Arizona		45.7	1.5	47.2	New Jersey		6.4	1.1	7.5
Arkansas	5.0	168.8	5.5	179.3	New Mexico	3.6	20.8	1.1	25.5
California	3.1	104.1	1.5	108.7	New York	7.9	104.3	1.7	113.9
Colorado		32.8	1.3	34.1	North Carolina	3.8	144.8	3.7	152.3
Connecticut	2.0	2.1		4.1	North Dakota	58.3	135.0	.4	193.7
Delaware		37.2		37.2	Ohio	26.0	128.6	.6	155.2
Florida	8.0	57.0	1.2	66.2	Oklahoma	8.3	198.0	4.8	211.1
Georgia	33.6	35.3	.4	69.3	Oregon	.4	115.0	3.5	118.9
Idaho	3.1	86.7	2.0	91.8	Pennsylvania	51.7	81.5	4.4	137.6
Illinois	67.9	273.5	2.6	344.0	Rhode Island		10.1	.9	11.0
Indiana	15.5	93.0	8.7	117.2	South Carolina	26.0	108.5	3.5	138.0
Iowa	6.4	324.4	18.0	348.8	South Dakota	38.9	77.2	9.8	125.9
Kansas	22.7	113.0	1.0	136.7	Tennessee	13.4	52.0	4.0	69.4
Kentucky	11.4	263.6	.5	275.5	Texas	18.5	508.3	22.7	549.5
Louisiana	8.9	121.0	1.3	131.2	Utah	4.1	50.9	.5	55.5
Maine	.5	39.0	2.5	42.0	Vermont	.3	11.2	1.1	12.6
Maryland	17.8	12.9	1.8	32.5	Virginia	35.4	639.9	2.8	678.1
Massachusetts		1.6	2.1	3.7	Washington		63.5	5.1	68.6
Michigan	46.6	79.6	.7	126.9	West Virginia	15.0	25.3	.3	40.6
Minnesota	1.8	593.8	33.7	629.3	Wisconsin	.4	197.0	3.1	200.5
Mississippi	19.1	78.4	4.7	102.2	Wyoming	2.8	44.1		46.9
Missouri	7.0	394.4	1.1	402.5	Hawaii	1.9			1.9
Montana	18.1	78.4	1.0	97.5					
Nebraska	23.2	131.4	3.3	157.9	Total	661.0	6,012.1	174.2	6,847.3
Nevada	16.2	62.5	.2	78.9					

[1] Includes some secondary roads within municipalities.

TABLE 11.—*Mileage of projects completed during the fiscal year 1937*—Continued

TOTAL

State	Federal aid, 1917–33	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Total
				High-ways	Grade cross-ings	
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Alabama		34.4	9.0	111.5	10.2	165.1
Arizona		.6	81.0	124.1	13.9	219.6
Arkansas		15.8	2.0	275.2	38.9	331.9
California		5.1	262.5	177.6	9.8	455.0
Colorado			120.1	52.3	13.1	185.5
Connecticut		4.8	14.2	4.6	.6	24.2
Delaware		.6	33.0	48.9	.3	82.8
Florida	6.5	10.6	22.4	75.2	9.0	123.7
Georgia		93.9	122.7	53.5	.7	270.8
Idaho	2.5	4.7	237.6	176.9	11.5	433.2
Illinois	9.6	80.2	127.6	400.2	15.6	633.2
Indiana	5.3	55.2	150.6	135.1	14.3	360.5
Iowa		6.9	393.4	386.8	42.6	829.7
Kansas		26.7	665.7	283.8	19.0	995.2
Kentucky		21.2	100.8	287.1	3.9	413.0
Louisiana	.4	28.6	58.2	129.8	2.5	219.5
Maine		1.0	50.2	54.7	7.5	113.4
Maryland		33.9		17.6	2.0	53.5
Massachusetts		3.1	3.1	2.7	3.6	12.5
Michigan		79.5	286.9	262.2	28.6	657.2
Minnesota		11.0	495.9	696.2	86.7	1,289.8
Mississippi		58.1		170.9	46.7	275.7
Missouri		20.2	254.0	409.4	5.9	689.5
Montana		28.8	280.5	160.8	18.3	488.4
Nebraska		46.0	177.6	319.3	90.4	633.3
Nevada		16.9	151.3	72.1	1.3	241.6
New Hampshire		.5	22.8	25.5	1.7	50.5
New Jersey		7.4	38.2	16.2	2.3	64.1
New Mexico		10.4	271.6	105.5	15.8	403.3
New York		21.9	190.0	143.5	8.8	364.2
North Carolina		22.0	341.5	195.5	11.5	570.5
North Dakota		122.3	.4	284.0	33.2	439.9
Ohio		35.2	55.2	150.9	.7	242.0
Oklahoma		11.7	136.2	343.6	27.7	519.2
Oregon		5.6	110.8	154.6	5.1	276.1
Pennsylvania		62.5	114.4	100.5	13.2	290.6
Rhode Island		1.1	4.0	18.8	1.9	25.8
South Carolina		35.6	53.8	178.6	8.7	276.7
South Dakota		98.4	190.4	278.0	44.9	611.7
Tennessee		18.1	97.2	99.7	10.4	225.4
Texas		29.0	604.6	882.4	83.8	1,599.8
Utah		4.3	138.0	152.3	1.3	295.9
Vermont		3.4	60.3	17.9	2.6	84.2
Virginia		41.6	180.1	668.2	12.3	902.2
Washington		.6	156.6	129.7	14.2	301.1
West Virginia		23.3	39.3	43.6	.3	106.5
Wisconsin		9.0	172.7	316.5	11.5	509.7
Wyoming		4.3	263.1	119.9	3.6	390.9
Hawaii		4.2	.8	8.9	.7	14.6
District of Columbia		1.5		3.7	.2	5.4
Total	24.3	1,261.7	7,342.3	9,326.5	813.3	18,768.1

21283—37——5

TABLE 12.—*Mileage of projects under contract on June 30, 1937*

ON THE FEDERAL-AID HIGHWAY SYSTEM OUTSIDE OF MUNICIPALITIES

State	Federal aid, 1917–33	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Federal aid, grade crossings	Total
				High-ways	Grade crossings		
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Alabama		3.4	65.8	1.3			70.5
Arizona		.1	47.0		0.7		47.8
Arkansas		.6	224.4	1.2	10.7		236.9
California			183.8	5.8	3.0		192.6
Colorado			119.5		1.6		121.1
Connecticut			8.7		1.9		10.6
Delaware			12.3	.2			12.5
Florida		2.3	61.7	4.0	1.3		69.3
Georgia		30.0	186.9	26.1	5.1		248.1
Idaho			142.2	.5	1.2		143.9
Illinois			348.0		2.0		350.0
Indiana			170.1	8.5	1.6	0.2	180.4
Iowa			182.6		2.8		185.4
Kansas			287.4	14.5	8.0		309.9
Kentucky			85.4	3.6	3.0		92.0
Louisiana			55.2	13.6	6.5		75.3
Maine			46.5	1.4	1.0		48.9
Maryland			23.8	9.1			32.9
Massachusetts			20.3	1.0	1.0		22.3
Michigan			154.6		1.3		155.9
Minnesota		3.7	164.9		1.5		170.1
Mississippi		13.9	176.3	9.6	33.8		233.6
Missouri		4.9	375.4		8.5		388.8
Montana			255.3		.8		256.1
Nebraska			537.2	2.7	.4		540.3
Nevada			91.8				91.8
New Hampshire			5.0	.5	.3		5.8
New Jersey		6.9	20.3				27.2
New Mexico			216.1				216.1
New York		.5	296.8	.6	7.1		305.0
North Carolina		15.4	354.2	18.0	9.9		397.5
North Dakota		36.2	262.8	9.0	28.7		336.7
Ohio		1.4	84.6	13.2	5.2		104.4
Oklahoma	23.1		165.2	4.8	2.4		195.5
Oregon			181.6	2.6	1.0	1.8	187.0
Pennsylvania		6.4	166.2	21.1	14.4		208.1
Rhode Island			18.1				18.1
South Carolina		1.4	343.4		17.6		362.4
South Dakota		17.4	225.8	26.7	63.5		333.4
Tennessee			73.8	13.8	1.8		89.4
Texas	8.1		874.9	.3	1.7		885.0
Utah			104.3		1.9		106.2
Vermont			34.0		1.5		35.5
Virginia		10.7	114.3		1.6		126.6
Washington			72.8				72.8
West Virginia		.7	53.7	6.3	4.3		65.0
Wisconsin			248.8	2.7	6.4	.5	258.4
Wyoming			288.3	.1	.6		289.0
Hawaii		2.2	17.9	1.5	1.2		22.8
Total	31.2	158.1	8,250.0	224.3	268.8	2.5	8,934.9

TABLE 12.—*Mileage of projects under contract on June 30, 1937*—Continued

ON THE FEDERAL-AID HIGHWAY SYSTEM IN MUNICIPALITIES

State	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Federal aid, grade crossings	Total
			Highways	Grade crossings		
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Alabama	3.9	1.4		1.2		6.5
Arizona		.1				.1
Arkansas	.8	1.4	17.4	1.7		21.3
California		3.0	3.1			6.1
Connecticut	.3		.8			1.1
Delaware			6.0			6.0
Florida	.5	4.0	2.1	1.1		7.7
Georgia	7.7	7.0	1.5	.8		17.0
Idaho		2.0		.7		2.7
Illinois	1.3	22.9		2.9		27.1
Indiana		14.7	1.9	2.7		19.3
Iowa	5.0	9.9	.3	3.6		18.8
Kansas		5.5	.8	2.4		8.7
Kentucky	.8	4.8	1.2	2.7		9.5
Louisiana			3.4	.9		4.3
Maine		2.2	.1			2.3
Maryland			1.7			1.7
Massachusetts			5.0	.7		5.7
Michigan		22.2		.5		22.7
Minnesota	2.5	23.0	2.1	1.7		29.3
Mississippi	.3	56.5	20.7	2.0		79.5
Missouri	.9	16.8	4.7	2.0		24.4
Montana		1.7				1.7
Nebraska	.5	9.9	1.0	1.9		13.3
New Hampshire				.2		.2
New Jersey	.6		4.7	.4		5.7
New Mexico				.4		.4
New York	1.1	3.2	3.8	1.2		9.3
North Carolina	.2	5.2	1.4	1.3		8.1
North Dakota	2.8	7.3	9.9	2.4		22.4
Ohio	.7		1.5	1.7		3.9
Oklahoma		1.6	2.5	1.1		5.2
Oregon	.7	2.6	3.8	1.2	0.7	9.0
Pennsylvania	4.2	4.0	4.9	6.0		19.1
South Carolina	1.2	10.7	10.9	3.2		26.0
South Dakota	2.5	3.6	24.6	4.6		35.3
Tennessee		1.3	1.6	.5		3.4
Texas		7.9		1.4		9.3
Utah			2.5	.5		3.0
Vermont			.4	.1		.5
Virginia	.3		1.6	1.3		3.2
Washington		2.0		.3		2.3
West Virginia	1.3	2.2	2.9	1.2		7.6
Wisconsin		12.4	.3			12.7
Wyoming	.3	.3		.7		1.3
Total	40.4	273.3	151.1	59.2	.7	524.7

ON SECONDARY OR FEEDER ROADS IN MUNICIPALITIES

State	Works Program		Federal aid, grade crossings	Total	State	Works Program		Federal aid, grade crossings	Total
	Highways	Grade crossings				Highways	Grade crossings		
	Miles	*Miles*	*Miles*	*Miles*		*Miles*	*Miles*	*Miles*	*Miles*
Alabama	1.3	0.7		2.0	Nevada	0.3	0.2		0.5
Arkansas	1.2	1.2		2.4	New Hampshire	2.8	.1		2.9
California	5.8	1.2		7.0	New Jersey	1.9	2.7		4.6
Colorado		.8		.8	New Mexico		.1		.1
Connecticut		.3		.3	New York	.5	1.6		2.1
Delaware	.2			.2	North Carolina	5.9	1.6		7.5
Florida	2.8	.6		3.4	North Dakota		1.1		1.1
Georgia	8.8	.6		9.4	Ohio	6.8	.7		7.5
Idaho		.3		.3	Oklahoma	8.4	.9		9.3
Illinois	1.0	.6		1.6	Pennsylvania	32.4	2.1		34.5
Indiana	6.0	1.2		7.2	Rhode Island		.2		.2
Iowa	1.3	.6		1.9	South Carolina	9.6	.1		9.7
Kansas	.7			.7	South Dakota	.8	1.0		1.8
Kentucky	.6	.3		.9	Tennessee	2.6	2.8		5.4
Louisiana	2.8	.5		3.3	Texas	6.0	2.5		8.5
Maine	1.9			1.9	Utah	7.0	1.0		8.0
Maryland		.4		.4	Virginia		.1		.1
Michigan		.4		.4	Washington	1.3	1.2	0.1	2.6
Minnesota	11.0	.9		11.9	West Virginia		1.3		1.3
Mississippi	1.5	.1		1.6	Wisconsin	.7	1.5		2.2
Missouri	2.0	1.1		3.1	Wyoming		.4		.4
Montana	1.1			1.1					
Nebraska	4.6	1.1		5.7	Total	141.6	36.1	.1	177.8

TABLE 12.—*Mileage of projects under contract on June 30, 1937*—Continued

ON SECONDARY OR FEEDER ROADS OUTSIDE OF MUNICIPALITIES

State	Public Works, 1934–35 [1]	Works Program		Federal aid, secondary or feeder	Total
		Highways	Grade crossings		
	Miles	*Miles*	*Miles*	*Miles*	*Miles*
Alabama		24.1	1.0		25.1
Arizona		7.3	.5		7.8
Arkansas	11.2	23.4	.4		35.0
California		11.1	.6		11.7
Colorado		6.0			6.0
Connecticut		14.9	.4		15.3
Delaware		11.5			11.5
Florida		9.5	10.4		19.9
Georgia	21.3	48.3	3.6		73.2
Illinois	12.3	25.1	.7		38.1
Indiana		84.0	1.6		85.6
Iowa		75.0	4.8		79.8
Kansas	1.3	15.1			16.4
Kentucky		14.8	.6		15.4
Louisiana	18.4	28.5	.2		47.1
Maine	.9	10.3	1.6		12.8
Maryland	1.3	6.6	2.2		10.1
Massachusetts		10.1	4.2		14.3
Michigan		4.8	.6		5.4
Minnesota		39.6	4.8		44.4
Mississippi	6.7	26.7	9.1		42.5
Missouri	.3	12.9	.7	128.4	142.3
Montana		9.0			9.0
Nebraska	9.9	36.8	1.0		47.7
Nevada		5.0			5.0
New Hampshire		10.2	1.0		11.2
New Jersey	1.1	13.3	.8		15.2
New Mexico	.2	32.3			32.5
New York		17.6	2.1		19.7
North Carolina		48.3	1.8		50.1
North Dakota		23.3	.2		23.5
Ohio	4.0	116.4	6.7		127.1
Oklahoma	.4	27.9	2.2		30.5
Oregon	.7	3.6	.5	18.2	23.0
Pennsylvania	5.2	106.7	3.1		115.0
South Carolina	8.1	43.4	1.6		53.1
South Dakota	13.0	30.7	7.1		50.8
Tennessee	9.4	20.9	6.5		36.8
Texas	.4	19.6	1.5		21.5
Utah		21.0	.8		21.8
Vermont		1.3	.2		1.5
Virginia	11.5	81.5	1.1		94.1
Washington			.9		.9
West Virginia	7.6	42.4	.5		50.5
Wisconsin		7.4	1.4		8.8
Wyoming		12.5		7.2	19.7
Hawaii		7.0	.7		7.7
Total	145.2	1,247.7	89.7	153.8	1,636.4

[1] Includes some secondary roads in municipalities.

TOTAL

State	Federal aid, 1917–33	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Federal aid, secondary or feeder	Federal aid, grade crossings	Total
				Highways	Grade crossings			
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Alabama		7.3	67.1	26.8	2.9			104.1
Arizona		.1	47.1	7.3	1.2			55.7
Arkansas		12.6	225.8	43.3	13.9			295.6
California			186.9	25.7	4.8			217.4
Colorado			119.5	6.0	2.4			127.9
Connecticut		.3	8.7	15.7	2.6			27.3
Delaware			12.3	17.9				30.2
Florida		2.9	65.7	18.3	13.4			100.3
Georgia		58.9	194.0	84.6	10.2			347.7
Idaho			144.1	.6	2.2			146.9
Illinois		13.7	370.9	26.1	6.1			416.8
Indiana			184.8	100.4	7.1		0.2	292.5

TABLE 12.—*Mileage of projects under contract on June 30, 1937*—Continued

TOTAL—Continued

State	Federal aid, 1917–33	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Federal aid, secondary or feeder	Federal aid, grade crossings	Total
				High-ways	Grade crossings			
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Iowa		5.0	192.5	76.5	11.9			285.9
Kansas		1.3	292.9	31.1	10.4			335.7
Kentucky		.8	90.2	20.3	6.5			117.8
Louisiana		18.4	55.2	48.2	8.2			130.0
Maine		1.0	48.6	13.7	2.6			65.9
Maryland		1.3	23.8	17.4	2.6			45.1
Massachusetts			20.3	16.2	5.8			42.3
Michigan			176.7	4.8	2.9			184.4
Minnesota		6.2	187.9	52.6	9.0			255.7
Mississippi		20.9	232.8	58.5	45.0			357.2
Missouri		6.0	392.3	19.6	12.3	128.4		558.6
Montana			257.0	10.1	.8			267.9
Nebraska		10.4	547.1	45.0	4.5			607.0
Nevada			91.8	5.3	.2			97.3
New Hampshire			5.1	13.5	1.5			20.1
New Jersey		8.6	20.3	19.9	3.9			52.7
New Mexico		.2	216.1	32.3	.5			249.1
New York		1.6	300.1	22.5	11.9			336.1
North Carolina		15.6	359.5	73.6	14.5			463.2
North Dakota		39.0	270.1	42.1	32.5			383.7
Ohio		6.0	84.6	137.8	14.5			242.9
Oklahoma	23.1	.4	166.8	43.6	6.6			240.5
Oregon		1.5	184.2	10.0	2.6	18.2	2.5	219.0
Pennsylvania		15.9	170.1	165.1	25.6			376.7
Rhode Island			18.1		.2			18.3
South Carolina		10.6	354.1	64.0	22.5			451.2
South Dakota		32.8	229.4	82.9	76.2			421.3
Tennessee		9.4	75.1	39.0	11.5			135.0
Texas	8.1	.4	882.8	25.9	7.1			924.3
Utah			104.3	30.6	4.1			139.0
Vermont			34.0	1.7	1.8			37.5
Virginia		22.5	114.3	83.2	4.0			224.0
Washington			74.8	1.2	2.5		.1	78.6
West Virginia		9.6	55.8	51.7	7.3			124.4
Wisconsin			261.2	11.1	9.3		.5	282.1
Wyoming		.3	288.6	12.5	1.8	7.2		310.4
Hawaii		2.2	17.9	8.5	1.9			30.5
Total	31.2	343.7	8,523.3	1,764.7	453.8	153.8	3.3	11,273.8

TABLE 13.—*Mileage of projects approved but not under contract on June 30, 1937*

ON THE FEDERAL-AID HIGHWAY SYSTEM OUTSIDE OF MUNICIPALITIES

State	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Federal aid, grade crossings	Total
			Highways	Grade crossings		
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Alabama		159.4				159.4
Arizona		11.8				11.8
Arkansas		23.1				23.1
California		24.6				24.6
Colorado		3.3				3.3
Connecticut	1.2	.6				1.8
Delaware		21.3		0.2	0.1	21.6
Florida		1.8				1.8
Georgia		34.3	1.40	1.5		49.8
Idaho		15.9				15.9
Illinois		72.9				72.9
Indiana		18.9				18.9
Iowa		19.6				19.6
Kansas		70.6				70.6
Kentucky		60.8				60.8
Louisiana		19.6		.5		20.1
Maine		15.1		.4		15.5
Maryland	.3	7.4	1.2	.5		9.4
Massachusetts		2.3	.3			2.6
Michigan		54.5				54.5
Minnesota		10.6				10.6
Mississippi		38.7				38.7
Missouri		150.1				150.1

TABLE 13.—*Mileage of projects approved but not under contract on June 30, 1937*—Continued

ON THE FEDERAL-AID HIGHWAY SYSTEM OUTSIDE OF MUNICIPALITIES—Con.

State	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Federal aid, grade crossings	Total
			Highways	Grade crossings		
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Montana		58.9				58.9
Nebraska		81.9	0.5	5.6		88.0
Nevada		24.5				24.5
New Hampshire		2.7				2.7
New Jersey				.4		.4
New Mexico	1.2	18.2		.6		20.0
New York		51.2				51.2
North Carolina	.3	34.1				34.4
North Dakota		29.8	3.7			33.5
Ohio		36.5				36.5
Oklahoma		37.9		1.2		39.1
Oregon		1.2				1.2
Pennsylvania		32.5	.3	3.1		35.9
Rhode Island		1.2				1.2
South Carolina		15.4		.9		16.3
South Dakota		11.6				11.6
Tennessee		12.9				12.9
Texas		25.5				25.5
Utah		17.0				17.0
Vermont		14.9				14.9
Virginia		12.1		.1		12.2
Washington		16.8				16.8
West Virginia		11.1		.1		11.2
Wisconsin		20.9				20.9
Wyoming		34.3				34.3
Hawaii		4.7				4.7
Total	3.0	1,445.0	20.0	15.1	0.1	1,483.2

ON THE FEDERAL-AID HIGHWAY SYSTEM IN MUNICIPALITIES

Alabama		9.3				9.3
Arizona		.4				.4
California		6.5		0.5		7.0
Connecticut		.7	0.8			1.5
Delaware		.7				.7
Georgia	1.2	8.7	6.8			16.7
Idaho	1.9					1.9
Illinois		2.4				2.4
Indiana		1.2				1.2
Iowa		3.1	.7	.4		4.2
Kansas		2.3				2.3
Kentucky		1.8	.5	.4		2.7
Louisiana				5.6		5.6
Maine		.7				.7
Maryland	1.4					1.4
Massachusetts	.1			.4		.5
Michigan	.5	5.2	.3	.1		6.1
Minnesota		1.1				1.1
Mississippi	.2	1.8	.6			2.6
Missouri		6.4				6.4
Montana		1.9				1.9
Nebraska		.6	3.0			3.6
Nevada		1.6				1.6
New Jersey	.4	1.9				2.3
New York		7.4				7.4
North Carolina	.7	.9				1.6
North Dakota		.5	30.0			30.5
Ohio		.7		.2		.9
Oklahoma		1.2	.2	.3		1.7
Oregon		.1			0.1	.2
Pennsylvania			.9			.9
South Carolina	.8	1.7				2.5
Tennessee		.7		.4		1.1
Texas		1.0	4.1			5.1
Utah		13.7				13.7
Virginia	.5	6.8	.3	.5		8.1
Washington		.6				.6
West Virginia		.2		.2		.4
Wisconsin		2.4				2.4
Total	7.7	96.2	48.2	9.0	.1	161.2

TABLE 13.—*Mileage of projects approved but not under contract on June 30, 1937*—Continued

ON SECONDARY OR FEEDER ROADS IN MUNICIPALITIES

State	Works Program		Federal aid, secondary or feeder	Federal aid, grade crossings	Total
	Highways	Grade crossings			
	Miles	*Miles*	*Miles*	*Miles*	*Miles*
Georgia	7.3	1.2			8.5
Idaho			4.5		4.5
Illinois	1.2				1.2
Indiana				0.5	.5
Kentucky	1.3	.1			1.4
Louisiana		.5			.5
Missouri			2.0		2.0
Montana		.1			.1
New Jersey		.1			.1
Ohio	.2	.8			1.0
Oklahoma	2.8	.2			3.0
Pennsylvania	6.7	.3			7.0
South Dakota		.4			.4
Tennessee	.5				.5
Virginia	.4				.4
West Virginia		.1			.1
Total	20.4	3.8	6.5	.5	31.2

ON SECONDARY OR FEEDER ROADS OUTSIDE OF MUNICIPALITIES

State	Public Works, 1934–35 [1]	Works Program		Federal aid secondary or feeder	Total
		Highways	Grade crossings		
	Miles	*Miles*	*Miles*	*Miles*	*Miles*
Alabama			0.1		0.1
Colorado			.2		.2
Connecticut		1.3	.6		1.9
Georgia	4.9	42.3	3.7		50.9
Idaho			.5	9.1	9.6
Illinois	13.1	4.4			17.5
Kansas		13.9			13.9
Kentucky				75.3	75.3
Louisiana			7.7		7.7
Maryland	4.8	5.3	1.8		11.9
Missouri				74.1	74.1
Montana	.2				.2
Nebraska	3.7				3.7
New Jersey			1.1		1.1
New York				19.6	19.6
North Carolina	.6				.6
North Dakota		24.2			24.2
Ohio	1.5	5.5			7.0
Oklahoma		3.7	.2		3.9
Oregon			.3	12.4	12.7
Pennsylvania		6.1			6.1
South Carolina	.6				.6
South Dakota	6.2	2.8	17.4		26.4
Tennessee	2.0	6.0			8.0
Texas	7.1	2.9			10.0
Utah		.1			.1
Virginia			.5		.5
West Virginia		4.9			4.9
Wyoming	5.6				5.6
Total	50.3	123.4	34.1	190.5	398.3

[1] Includes some secondary roads within municipalities.

TABLE 13.—*Mileage of projects approved but not under contract on June 30, 1937*—Continued

TOTAL

State	Public Works, 1934–35	Federal aid, 1936–38	Works Program		Federal aid, secondary or feeder	Federal aid, grade crossings	Total
			High-ways	Grade crossings			
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Alabama		168.7		0.1			168.8
Arizona		12.2					12.2
Arkansas		23.1					23.1
California		31.1		.5			31.6
Colorado		3.3		.2			3.5
Connecticut	1.1	1.3	2.2	.6			5.2
Delaware		22.0		.2		0.1	22.3
Florida		1.8					1.8
Georgia	6.0	43.1	70.4	6.4			125.9
Idaho	1.9	15.9		.5	13.6		31.9
Illinois	13.1	75.3	5.6				94.0
Indiana		20.1				.5	20.6
Iowa		22.7	.7	.4			23.8
Kansas		72.9	13.9				86.8
Kentucky		62.6	1.8	.5	75.3		140.2
Louisiana		19.6		14.3			33.9
Maine		15.8		.4			16.2
Maryland	6.6	7.4	6.4	2.3			22.7
Massachusetts	.1	2.3	.3	.4			3.1
Michigan	.4	59.8	.3	.1			60.6
Minnesota		11.7					11.7
Mississippi	.2	40.5	.6				41.3
Missouri		156.5			76.1		232.6
Montana	.2	60.8		.1			61.1
Nebraska	3.7	82.5	3.5	5.6			95.3
Nevada		26.1					26.1
New Hampshire		2.7					2.7
New Jersey	.5	1.9		1.5			3.9
New Mexico	1.2	18.2		.6			20.0
New York		58.6			19.6		78.2
North Carolina	1.7	34.9					36.6
North Dakota		30.2	58.0				88.2
Ohio	1.5	37.1	5.7	1.1			45.4
Oklahoma		39.1	6.6	2.0			47.7
Oregon		1.3		.3	12.4	.1	14.1
Pennsylvania		32.5	14.0	3.4			49.9
Rhode Island		1.2					1.2
South Carolina	1.4	17.1		.9			19.4
South Dakota	6.2	11.6	2.8	17.8			38.4
Tennessee	2.0	13.6	6.5	.4			22.5
Texas	7.1	26.6	6.9				40.6
Utah		30.7	.1				30.8
Vermont		14.9					14.9
Virginia	.5	18.9	.8	1.0			21.2
Washington		17.4					17.4
West Virginia		11.3	4.9	.4			16.6
Wisconsin		23.3					23.3
Wyoming	5.6	34.3					39.9
Hawaii		4.7					4.7
Total	61.0	1,541.2	212.0	62.0	197.0	.7	2,073.9

TABLE 14.—*Status of grade-crossing elimination and protection projects on June 30, 1937*

COMPLETED DURING FISCAL YEAR

State	Crossings eliminated					Separation structures reconstructed	Crossings protected		
	Public Works, 1934–35	Federal aid for 1936–38	Works Program		Total		Public Works, 1934–35	Works Program, grade crossings	Total
			Highways	Grade crossings					
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Alabama			1	38	39	1		12	12
Arizona				12	12				
Arkansas	1			30	31	5		2	2
California	1	1		28	30	6			
Colorado		1		20	21	1			
Connecticut	1				1	1			
Delaware	1			1	2				
Florida				18	18	4			
Georgia				3	3	2	8		8
Idaho	2			14	16	1		7	7
Illinois	6			50	56	3	203		203
Indiana	2			22	24	11	8		8
Iowa				71	71	6		5	5
Kansas	1			44	45		1	5	6
Kentucky				13	13	3			
Louisiana				7	7				
Maine				15	15			2	2
Maryland				3	3	3		2	2
Massachusetts	1			10	11	2	1		1
Michigan		1		35	36	4	2		2
Minnesota	2			68	70	11	1	35	36
Mississippi	2			33	35	3	2	1	3
Missouri	3			15	18				
Montana			1	33	34	7			
Nebraska				64	64	2		8	8
Nevada			1	3	4	3	2		2
New Hampshire			1	3	4	3			
New Jersey	4	1		7	12	2		1	1
New Mexico				8	8	1			
New York	3	1	1	22	27	22			
North Carolina	2			25	27	13	84		84
North Dakota	1			25	26	2			
Ohio	2			3	5	1		2	2
Oklahoma	3			39	42	4		2	2
Oregon	1	1		10	12	5	9	2	11
Pennsylvania				35	35	9		9	9
Rhode Island				4	4	2			
South Carolina				22	22	6	4	3	7
South Dakota				27	27	3		25	25
Tennessee	1		1	15	17	2		19	19
Texas	2			97	99	13		37	37
Utah	1			3	4			1	1
Vermont	1			4	5	3		15	15
Virginia	2			29	31	12	1	9	10
Washington				19	19	10	2	8	10
West Virginia				1	1			4	4
Wisconsin		1	2	26	29	4	30		30
Wyoming	1			7	8				
District of Columbia				3	3				
Hawaii	1			2	3				
Total	48	7	8	1,086	1,149	196	358	216	574

TABLE 14.—*Status of grade-crossing elimination and protection projects on June 30, 1937*—Continued

UNDER CONTRACT

State	Crossings eliminated					
	Public Works, 1934–35	Federal aid for 1936–38	Works Program		Federal aid, grade crossings 1938	Total
			Highways	Grade crossings		
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
Alabama				9		9
Arizona				2		2
Arkansas				18		18
California				15		15
Colorado				9		9
Connecticut				7		7
Florida	1			12		13
Georgia	1			24		25
Idaho				8		8
Illinois	2			23		25
Indiana		3		20	2	25
Iowa				36		36
Kansas				14		14
Kentucky				11		11
Louisiana		2		17		19
Maine				6		6
Maryland	1			3		4
Massachusetts		2	1	16		19
Michigan				6		6
Minnesota				15		15
Mississippi				23		23
Missouri			1	34		35
Montana				1		1
Nebraska				15		15
Nevada				1		1
New Hampshire				6		6
New Jersey	1			15		16
New Mexico				5		5
New York	4	1	1	25		31
North Carolina				24		24
North Dakota				26		26
Ohio				39		39
Oklahoma		1		17		18
Oregon				6	2	8
Pennsylvania		1		45		46
Rhode Island						
South Carolina	1			21		22
South Dakota				37		37
Tennessee				30		30
Texas		1		26		27
Utah				14		14
Vermont				3		3
Virginia				13		13
Washington		1		3		4
West Virginia				20		20
Wisconsin		3		10	1	14
Wyoming				5		5
Hawaii				3		3
Total	11	15	3	738	5	772

TABLE 14.—*Status of grade-crossing elimination and protection projects on June 30, 1937*—Continued

UNDER CONTRACT—Continued

State	Separation structures reconstructed	Crossings protected				
		Public Works, 1934-35	Works Program		Federal aid, grade crossings 1938	Total
			Highways	Grade crossings		
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
Arizona				3		3
Arkansas	1			30		30
California		62				62
Connecticut				1		1
Florida	1					
Georgia	5	1		52		53
Idaho	1			14		14
Illinois	5	63				63
Indiana	1	44		163		207
Iowa	2			3		3
Kansas	1					
Kentucky	8	9				9
Louisiana	2					
Maine	1			2		2
Maryland				20		20
Massachusetts	2					
Michigan	3					
Minnesota	2			14		14
Mississippi	3	2		14		16
Missouri	1			2		2
Montana	1					
Nebraska	1			16		16
Nevada				5		5
New Hampshire	1			7		7
New Jersey	5					
New Mexico		2				2
New York	26					
North Carolina	3			108		108
North Dakota	2					
Ohio	7			1		1
Oklahoma	6			39		39
Oregon	1					
Pennsylvania	11					
Rhode Island	1					
South Carolina	8			45		45
South Dakota	3			28		28
Tennessee	1			18		18
Texas	2			121		121
Vermont	2			5	2	7
Virginia	5	2		13		15
Washington	2		1	3		4
West Virginia	3			1		1
Wisconsin	3	1		5		6
Total	133	186	1	733	2	922

TABLE 14.—*Status of grade-crossing elimination and protection projects on June 30, 1937*—Continued

APPROVED BUT NOT UNDER CONTRACT

State	Crossings eliminated				Separation structures reconstructed
	Federal aid for 1936–38	Works Program, grade crossings	Federal aid, grade crossings 1938	Total	
	Number	*Number*	*Number*	*Number*	*Number*
Alabama		1		1	
California		6		6	
Colorado		1		1	
Connecticut		1		1	
Delaware		2		2	
Georgia	1	12		13	3
Idaho		1		1	
Illinois	1			1	
Indiana			1	1	
Kentucky		3		3	1
Louisiana		7		7	1
Maine		1		1	
Maryland		4		4	2
Massachusetts		1		1	
Michigan	3			3	1
Montana		1		1	
Nebraska		4		4	
New Jersey		2		2	3
New Mexico		1		1	
Ohio		14		14	
Oklahoma		4		4	2
Oregon		1		1	
Pennsylvania		9		9	
South Carolina					2
South Dakota		11		11	
Tennessee		1		1	
Virginia		3		3	2
Washington	1			1	
West Virginia		5		5	1
Wisconsin	1			1	
Total	7	96	1	104	18

TABLE 15.—*Mileage, by types of construction, of projects completed during the fiscal year 1937*

State	Graded and drained	Sand-clay		Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Grade separations		Total
		Untreated	Treated	Untreated	Treated	Untreated	Treated							Railroad and highways	Between highways	
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Alabama	4.1	4.1	34.5	67.0	19.2		9.2	12.5		2.1	10.2		0.9	1.3		165.1
Arizona	11.7			76.3	24.5			98.3		.4	7.7		.6	.1		219.6
Arkansas	12.3			221.0	8.8		1.9	63.7	1.1		21.3		1.2	.6		331.9
California	39.8			22.2	88.3		.1	135.2	4.0	54.1	101.0		2.0	7.8	0.5	455.0
Colorado	12.7			176.2							.1		1.3	1.2		185.5
Connecticut					2.3	0.5	2.0		.6	2.2	16.3		.1	.2		24.2
Delaware	5.6			35.1						1.5	40.4		.1	.1		82.8
Florida	28.4		15.5				38.0	21.3		.7	18.9		.3	.6		123.7
Georgia	18.1	.3	27.4	32.8	41.9		71.1	4.2		11.7	61.7		1.5	.1		270.8
Idaho	50.3			195.1				186.2			.3		.7	.6		433.2
Illinois	323.4				14.5	136.3	27.3	7.3			115.4	2.5	4.6	1.9		633.2
Indiana	107.4			79.8	5.0			28.7		14.3	121.7		1.9	1.5	.2	360.5
Iowa	132.8			341.8	29.4			92.3			226.9		2.6	3.9		829.7
Kansas	199.6	43.0		335.5				370.1		1.0	40.9	.1	2.8	2.2		995.2
Kentucky	180.0			139.2		.5		42.7		4.8	43.8		1.1	.9		413.0
Louisiana	13.2			110.5	10.4			8.3			74.8		1.8	.5		219.5
Maine				55.1	22.6				18.3	14.8	2.4			.2		113.4
Maryland	9.9	1.6		21.4			2.6		9.1	5.7	3.4		.3	.1		53.5
Massachusetts								1.4	5.3	2.0	2.1	.1	.8	.8		12.5
Michigan	202.4			45.1				100.8		81.3	224.5	.5	.5	2.1		657.2
Minnesota	566.6	2.3		504.4	6.5	8.1		19.7		21.3	158.6	.2	.8	.8	.5	1,289.8
Mississippi	96.8	6.8	18.7	126.7	16.2					.2	7.0	.3	2.5	.5		275.7
Missouri	88.1		10.4	352.8	40.4			64.7		9.9	120.0		2.2	.9	.1	689.5
Montana	85.4			148.5	157.5			88.8		3.3	1.8		2.1	1.0		488.4
Nebraska	325.1	111.3						100.9			90.6	.2	4.0	1.2		633.3
Nevada	.2			106.9				130.0			3.5		.2	.8		241.6
New Hampshire						7.0	33.8	2.4	1.5	2.0	3.7			.1		50.5
New Jersey	3.9			5.1	.3					4.3	49.7	.2	.2	.4		64.1
New Mexico	38.4			172.0	56.1			128.4		5.3			2.4	.7		403.3
New York	9.0			31.2	54.9			21.4	10.9	58.4	168.7	.8	5.0	3.8	.1	364.2
North Carolina	18.2	110.2	168.6	45.1	111.2			33.2		2.2	79.9		1.1	.8		570.5
North Dakota	54.5			317.5	.2			65.0			1.1		.5	1.1		439.9
Ohio	.4	3.0		124.8		13.1	8.2		.1	19.0	51.7	21.1	.5	.1		242.0
Oklahoma	4.4	17.7		336.3	7.1		1.5			57.0	90.1		3.5	1.6		519.2
Oregon	24.0			49.7	106.0	.2	1.5	32.3	26.9	14.1	19.8		.6	1.0		276.1
Pennsylvania	45.4			10.1	4.9	4.2	32.5		61.7	11.2	119.0	.6	.6	.4		290.6
Rhode Island					3.4			7.5	1.7	10.2	2.7			.3		25.8
South Carolina	52.3	132.1	43.9		6.1		1.9	25.8		4.6	9.0		.5	.5		276.7

TABLE 15.—*Mileage, by types of construction, of projects completed during the fiscal year 1937*—Continued

State	Graded and drained	Sand-clay		Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Grade separations		Total
		Untreated	Treated	Untreated	Treated	Untreated	Treated							Railroad and highways	Between highways	
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
South Dakota	152.2			234.0	12.4			192.4		0.2	19.6		0.6	0.3		611.7
Tennessee				89.7		3.7	4.0			31.0	94.8	.4	1.4	.4		225.4
Texas	398.5		5.4	434.4	428.5		16.4	16.0		111.3	179.6	1.0	6.3	2.3	0.1	1,599.8
Utah	18.2			110.5	2.2			95.7		54.4	14.6		.3			295.9
Vermont				4.5	6.2			56.9	6.4	1.4	6.6		.5	1.7		84.2
Virginia	30.5	39.9	54.8	526.9	58.4	.4	152.5		1.6	12.1	20.1	.3	3.9	.8		902.2
Washington	4.5			139.7	56.2			9.0	27.3	6.2	54.3		1.9	2.0		301.1
West Virginia	14.0			8.1	13.3		26.4	28.1		2.9	13.5		.2			106.5
Wisconsin	144.9			282.9	.4					.1	78.8		1.1	1.5		509.7
Wyoming	174.5			75.7	30.4			108.2	.2				1.4	.5		390.9
Hawaii	1.4					.7	1.3		10.4				.2	.6		14.6
District of Columbia										4.3	.9			.2		5.4
Total	3,703.1	471.7	379.2	6,185.6	1,445.7	174.7	432.2	2,399.4	187.1	643.5	2,593.5	28.3	69.6	53.0	1.5	18,768.1

TABLE 16.—*Mileage, by types of construction, of projects under contract on June 30, 1937*

State	Graded and drained	Sand-clay		Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Grade separations		Total
		Untreated	Treated	Untreated	Treated	Untreated	Treated							Railroad and highway	Between highways	
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Alabama	16.2	4.3	34.0	8.3	38.1						2.3		0.6	0.3		104.1
Arizona	3.2			.6	35.3			12.2			4.0		.4			55.7
Arkansas	39.5			33.0	1.9		7.9	155.9		2.5	53.2		1.1	.6		295.6
California				20.3	22.0			94.2		45.3	33.9		1.2	.5		217.4
Colorado				106.3	.3			4.2		.1	14.7		.9	1.4		127.9
Connecticut					16.2				9.1	.6	1.2		.1	.1		27.3

Delaware				11.7						10.3	8.2					30.2
Florida	73.6		.5				10.9			.1	13.9		.9	.4		100.3
Georgia	13.9	9.4	37.4	93.5	76.5		73.6				39.9	0.8	1.7	1.0		347.7
Idaho	11.3			17.1				108.4	4.1	.3	5.2		.1	.4		146.9
Illinois	138.4			18.4	10.9	69.9	3.6	5.7		.2	166.0		3.1	.6		416.8
Indiana	62.0			29.0	21.7		2.2	1.1		36.5	136.6		1.1	2.3		292.5
Iowa	83.6			5.1							194.4		1.2	1.6		285.9
Kansas	42.3			166.4				49.9			73.0		2.4	1.7		335.7
Kentucky	14.1			13.1				16.3		14.8	58.3		.9	.3		117.8
Louisiana	48.0		4.6	21.1	1.0						51.3		2.4	1.6		130.0
Maine				14.6	29.5				13.2	7.1	1.3			.2		65.9
Maryland				7.0			.9				37.1		.1			45.1
Massachusetts								1.3	13.6	23.8	.2		.1	3.2	0.1	42.3
Michigan	1.6			15.5						2.7	163.3	.3	.4	.6		184.4
Minnesota	74.7	9.6		43.6	28.2			53.2		2.4	42.5	.8	.3	.3	.1	255.7
Mississippi	142.0		8.9	50.3	4.9					9.1	139.4		2.1	.5		357.2
Missouri	50.3			100.3	200.3			23.1		17.0	163.0		2.2	2.2	.2	558.6
Montana	53.0			78.4	16.0			119.0					1.5			267.9
Nebraska	42.2	49.7	59.1					422.0			25.0		7.5	1.5		607.0
Nevada				14.6				77.6		4.9			.2			97.3
New Hampshire							16.5		3.2	.1			.2	.1		20.1
New Jersey				10.1	.9				4.4	2.6	33.5		.1	1.0	.1	52.7
New Mexico	13.7			60.3	68.9			104.6			.5		1.1			249.1
New York	19.5			5.9	24.2			9.5	23.7	61.0	187.7	.3	1.3	2.9	.1	336.1
North Carolina	9.5	67.0	118.3	55.3	61.8		4.7	47.8		7.4	86.8		4.3	.3		463.2
North Dakota	113.4			115.7	44.9			107.4			1.1	.3	.3	.6		383.7
Ohio	18.6			106.2	.4	8.7	4.6			21.3	34.9	42.5	4.6	1.1		242.9
Oklahoma	.2			107.5	7.9			5.1		13.3	103.3		1.9	1.3		240.5
Oregon	7.7			47.1	50.5		11.2	27.7	43.2	14.1	16.1		.9	.5		219.0
Pennsylvania	4.6			71.7					55.6	39.5	197.5	5.3	1.4	1.1		376.7
Rhode Island									3.1	5.7	9.5					18.3
South Carolina	49.9	35.8	316.8					23.6		13.6	9.3		1.5	.7		451.2
South Dakota	134.7			80.2	106.1			65.3			33.9		.5	.6		421.3
Tennessee	2.9			57.1			5.9		5.3	23.0	36.8	2.0	1.0	1.0		135.0
Texas	253.7			140.0	302.3		10.9			.5	206.0	3.0	7.4	.5		924.3
Utah	2.2			33.3	8.9			85.3		6.9	1.9		.1	.4		139.0
Vermont				.3	9.9		1.6	17.1			8.4		.1	.1		37.5
Virginia	5.9	6.4	4.1	73.9	29.2		86.1			4.5	12.6		.9	.4		224.0
Washington	3.0			53.0				.5	.2	.7	19.4		.7	1.1		78.6
West Virginia	42.2			9.1		5.0	22.8	3.4		10.2	30.4		.5	.8		124.4
Wisconsin	62.0			80.6				11.6			126.2		1.0	.7		282.1
Wyoming	25.4			43.3	7.8			232.8					.4	.7		310.4
Hawaii	2.0				1.6		19.3		7.0				.5	.1		30.5
Total	1,681.0	182.2	583.7	2,018.8	1,228.1	83.6	282.7	1,885.8	185.7	402.1	2,583.7	55.3	63.2	37.3	.6	11,273.8

TABLE 17.—*Mileage, by types of construction, of projects approved but not under contract on June 30, 1937*

State	Graded and drained	Sand-clay		Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Grade separations, railroad and highway	Total
		Untreated	Treated	Untreated	Treated	Untreated	Treated								
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Alabama			109.4		58.1						0.1		1.2		168.8
Arizona					9.5			2.0			.5		.2		12.2
Arkansas								23.1							23.1
California								3.3		26.7	1.6				31.6
Colorado				3.5											3.5
Connecticut					1.2				0.7	1.1	2.2				5.2
Delaware										3.8	18.3			0.2	22.3
Florida											1.8				1.8
Georgia	3.8	5.1	7.0	39.6	32.4		19.3			8.3	9.2		1.0	.2	125.9
Idaho				17.4				14.0			.2		.3		31.9
Illinois	38.9				13.1	13.6	5.6				22.2		.6		94.0
Indiana	.1										20.3		.1	.1	20.6
Iowa											23.8				23.8
Kansas	2.9			79.6				.4			3.5		.4		86.8
Kentucky				87.5				23.3		.5	28.5		.2	.2	140.2
Louisiana	23.1										10.5			.3	33.9
Maine					3.0				4.1	8.2	.9				16.2
Maryland				6.6					1.6	1.0	13.2		.1	.2	22.7
Massachusetts									.8	2.3					3.1
Michigan	.1			.3						12.7	46.6	0.4	.5		60.6
Minnesota								10.4			1.3				11.7
Mississippi	12.3										28.6		.4		41.3
Missouri	25.3			82.8	94.0			4.7			25.4		.4		232.6
Montana	7.9			39.9				13.1					.2		61.1
Nebraska	33.3	1.5	7.9					16.9			35.4		.3		95.3
Nevada					4.9			20.4		.8					26.1
New Hampshire							1.5	1.2							2.7
New Jersey					.9					.2	2.7			.1	3.9
New Mexico				1.2				18.1					.1	.6	20.0
New York	7.8				14.1		5.4	4.2	3.6	1.1	41.9		.1		78.2
North Carolina			14.1		17.9			3.4			1.0		.2		36.6
North Dakota	31.7			22.8	19.4			14.3							88.2
Ohio				8.0			.4			3.1	28.5	5.2	.1	.1	45.4
Oklahoma	9.9			16.8				1.7		10.4	8.2		.5	.2	47.7
Oregon	.3				13.3						.4			.1	14.1
Pennsylvania				3.7			1.5		9.2	11.4	17.1	3.9	.5	2.6	49.9
Rhode Island											1.2				1.2
South Carolina	4.7		11.6							.4	1.8		.9		19.4
South Dakota	17.6			9.0				11.6					.2		38.4
Tennessee				12.2			2.1				8.1		.1		22.5

Texas	6.1			14.1	12.9					3.5	3.9		.1		40.6
Utah				10.2	5.7			14.8					.1		30.8
Vermont					8.3			3.4			3.1		.1		14.9
Virginia				3.1		.1	4.2			6.3	7.3			.2	21.2
Washington				10.1							7.0		.3		17.4
West Virginia	2.9							12.5			1.0			.2	16.6
Wisconsin	18.9										4.3		.1		23.3
Wyoming	7.1				27.1			5.6					.1		39.9
Hawaii							4.7								4.7
Total	254.7	6.6	150.0	468.4	335.8	13.7	44.7	222.4	20.0	101.8	431.6	9.5	9.4	5.3	2,073.9

CONSTRUCTION OF ROADS THROUGH PUBLIC LANDS AND FEDERAL RESERVATIONS

Throughout the West there are sparsely populated lands still held by the United States in public ownership, across which there is need for the construction of new roads and for the improvement of existing roads, mainly to serve the ever-increasing tourist traffic. In 14 States such areas, including unappropriated public lands, nontaxable Indian lands, and other Federal reservations exclusive of forest and park reservations, amount to more than 5 percent of the area of the State.

Special authorizations for the construction of roads in public lands have been made by six congressional acts, passed up to the the end of the fiscal year 1937. Funds totaling $17,500,000 have been made available for the fiscal years 1931–38, excepting the fiscal years 1932 and 1937. The authorization for the fiscal year 1939 is $2,500,000.

These public-lands funds may be expended, within Federal reservations, either on the Federal-aid system or on other main roads. Cooperative funds from the States may be used in conjunction with Federal funds, but contributions from the States are not required. Construction may be planned and supervised by the State highway departments, as in Federal-aid work, or may be handled directly by the Federal authority.

The public-lands projects consist generally of the grading of new roads, the reconstruction of old roads to higher standards of grade and alinement, and the subsequent improvement of these roads by addition of gravel and bituminous-mix surfacing. The large mileage of improvement required has necessitated low types of initial construction that are to be further improved as traffic requires.

During the year 246 miles of road were completed, consisting of new construction and the betterment of earlier improvements. This brings the total of completed Federal lands roads to 1,337 miles. Of the 1,337 miles, 7 percent consists of grading, 31 percent of gravel surfacing, and 59 percent bituminous-mix surfacing, miscellaneous improvements constituting about 3 percent.

Table 18 shows the cost and mileage of roads completed during the year and table 21 shows the types of road completed to the end of the fiscal year.

TABLE 18.—*Public-lands funds allotted to projects completed during the fiscal year 1937*

State	Public-lands funds	Estimated total cost	Miles	State	Public-lands funds	Estimated total cost	Miles
Arizona	$277,451	$287,220	33.7	North Dakota	$27,219	$27,219	6.0
California	111,822	143,954	7.7	Oregon	72,726	88,763	7.7
Colorado	115,245	117,807	4.3	Utah	220,081	240,862	14.1
Montana	123,409	123,983	6.7	Wyoming	161,275	161,309	39.3
Nevada	546,440	559,163	106.2				
New Mexico	375,560	376,023	20.1	Total	2,031,228	2,126,603	245.8

At the end of the year, the public-lands projects under contract and in large part under construction involved 91.5 miles as shown in table 19. Table 20 shows the mileage and funds involved in projects approved but not yet under contract and funds available for new work.

TABLE 19.—*Public-lands funds allotted to projects under contract and under construction, June 30, 1937*

State	Public-lands funds	Estimated total cost	Miles	State	Public-lands funds	Estimated total cost	Miles
Arizona	$73,396	$73,396	0.3	Oregon	$132,297	$132,297	9.6
California	275,666	336,143	13.8	South Dakota	36,392	54,942	7.0
Idaho	139,586	156,294	8.9	Wyoming	35,520	61,850	4.1
Nevada	350,008	363,624	31.1				
New Mexico	95,885	95,885	-------	Total	1,143,150	1,278,831	91.5
North Dakota	4,400	4,400	16.7				

TABLE 20.—*Public-lands funds allotted to projects approved but not under contract and balance available for new projects, June 30, 1937*

State	Public-lands funds	Estimated total cost	Miles	Balance available for new projects	State	Public-lands funds	Estimated total cost	Miles	Balance available for new projects
Arizona	$9,550	$9,550		$378,862	Oklahoma				$52,097
California	2,500	2,500		242,518	Oregon	$30,000	$61,989	5.9	11,744
Colorado				88,688	South Dakota	21,070	21,070	1.1	76,103
Idaho				36,000	Utah				258,693
Montana				159,129	Washington				38,349
Nevada				225,551	Wyoming				165,824
New Mexico				110,959					
North Dakota				68,617	Total	63,120	95,109	7.0	1,913,134

The fiscal year 1937 saw considerable advance made in the construction of the Colorado River bridge, near Parker, Ariz., and upon the following routes, important from the viewpoint of continuous Federal lands construction: The Ely-Tonopah Highway, in Nevada, and the Kingman-Boulder Dam Highway, in Arizona.

The Colorado River bridge near Parker, Ariz.—often called the Parker Bridge—crosses the Colorado River from Arizona to California. Construction was begun during the year, and at the close of the year was practically complete. It will provide the only means of crossing the Colorado River in that vicinity.

The Ely-Tonopah Highway, 102 miles in length, is a link in U. S. Route 6, that carries traffic directly across the State. During the year, three public-lands projects on this route were completed. Two sections were improved with bituminous surfacing for a total distance of 27 miles, while the third project consisted of grading and gravel surfacing 29 miles. Further improvements are in progress on 37 miles of the route.

TABLE 21.—*Mileage of Federal-lands roads, by types of construction, completed as of June 30, 1937*

State	Graded and drained	Gravel	Bituminous treatment	Bituminous mixture	Bituminous macadam	Bituminous concrete	Portland cement concrete	Bridges	Total
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Arizona	22.9	20.9		63.5				0.4	107.7
California		13.8		60.2				.3	74.3
Colorado		14.9		7.9				.1	22.9
Idaho	1.8	31.7		31.5					65.0
Montana		37.2		18.2				.2	55.6
Nevada		103.9		355.8				.1	459.8
New Mexico		24.6	10.8	18.5			6.0	.2	60.1
North Dakota	9.4	16.0						.1	25.5
Oklahoma				5.6		1.8	2.5		9.9
Oregon	39.6	84.0	3.9					.1	127.6
South Dakota	10.4	2.8						.1	13.3
Utah		39.6		119.6		6.8		.1	166.1
Washington	.3	14.3			2.6		3.7	.1	21.0
Wyoming	4.1	7.0	15.6	101.1				.3	128.1
Total	88.5	410.7	30.3	781.9	2.6	8.6	12.2	2.1	1,336.9

The Kingman-Boulder Dam Highway project is 25 miles in length. It forms part of an important through route crossing the Colorado River, and permits easy access to the world-famous Boulder Dam. In the past year 14.5 miles of gravel road was given a mixed bituminous surface and work is nearly completed on 11 miles of similar surfacing.

RESTORATION OF FLOOD-DAMAGED ROADS

The work of reconstructing flood-damaged roads in 11 States, with funds authorized in the years 1928–31, has been nearly completed.

At the beginning of the year all authorized funds had been absorbed in completed work in Florida, New Hampshire, South Carolina, and Vermont. All work planned in Alabama, Arkansas, Georgia, Louisiana, and Mississippi had been completed.

During the year 23 miles of flood-relief construction was completed, and 22 miles was under contract at the end of the year, as shown in table 22. Work under contract at the end of the year absorbed all of the available funds in Missouri, and Kentucky had an unobligated balance of $300,177.

TABLE 22.—*Flood-relief funds allotted to projects completed during the fiscal year and under contract at close of fiscal year 1937*

State	Flood-relief funds	Estimated total cost	Miles
COMPLETED DURING YEAR			
Kentucky	$86,048	$194,868	11.2
Louisiana	65,921	167,654	10.5
Missouri	46,256	93,009	1.4
Total	112,177	260,663	11.9
Grand total	198,225	455,531	23.1
UNDER CONTRACT AT END OF YEAR			
Kentucky	$113,660	$240,275	18.8
Missouri	496	14,660	3.4
Total	114,156	254,935	22.2

The Bureau has also furnished engineering supervision on a number of flood-relief projects at the request of the Works Progress Administration. These projects are financed by the Works Progress Administration and the States and, in some cases, partially with Works Program funds. The work consists of the reconstruction of flood-damaged bridges and bridge approaches, for the most part on secondary roads. This work is done by the contract method, and the Bureau cooperates closely with the State highway departments much the same as on Federal-aid construction.

Completed work of this class has aggregated 6.4 miles of bridges and approaches costing $1,440,266, and work is under contract or approved for contract on 32 miles estimated to cost $11,602,186. Details by States are shown in table 23.

TABLE 23.—*Funds allotted for reconstruction of flood-damaged bridges by the Works Progress Administration during the fiscal year 1937 to be supervised by the Bureau of Public Roads*

State	Works Progress flood-reconstruction funds	Estimated total cost	Miles [1]	State	Works Progress flood-reconstruction funds	Estimated total cost	Miles [1]
COMPLETED							
Connecticut	$19,250	$48,666	0.1	Virginia	$9,150	$12,200	--------
Maine	359,800	449,500	1.4				
New Hampshire	79,293	105,724	.3	Total	1,214,273	1,440,266	6.4
Pennsylvania	746,780	824,176	4.6				
UNDER CONTRACT							
Connecticut	$121,075	$194,380	0.6	Vermont	$82,879	$162,924	0.6
Maine	1,581,900	1,867,400	3.0	West Virginia	142,500	285,000	1.5
Massachusetts	1,880,492	3,140,176	4.4				
New Hampshire	624,032	837,301	1.5	Total	7,309,400	9,869,637	26.3
Pennsylvania	2,876,522	3,382,456	14.7				
APPROVED							
Connecticut	$63,200	$175,770	0.2	West Virginia	$68,500	$274,000	0.2
Massachusetts	629,866	871,220	1.9				
Pennsylvania	365,991	411,559	3.3	Total	1,127,557	1,732,549	5.6

[1] Bridges and bridge approaches.

Section 3 of the Hayden-Cartwright Act of June 18, 1934, authorized the Secretary of Agriculture to use an amount not to exceed $10,000,000, from any funds available for expenditure under the Federal Highway Act, in the repair and reconstruction of flood-damaged highways and bridges on the Federal-aid system, and authorized future appropriation of funds expended for such purposes. This provision has made possible the taking of immediate steps to repair damage caused by destructive floods that occurred in Eastern States in the spring of 1936 without waiting for specific authorization of funds. The States are required to match these flood-relief funds in the same manner as regular Federal-aid funds.

During the year work was completed in eight States, costing $2,247,522, of which $1,096,078 was supplied by the Federal Government, and work estimated to cost $2,591,569 and involving $1,265,284 of Federal funds was under contract or approved at the close of the year, as shown in table 24. Flood-damage funds paid to States during the year amounted to $1,048,751, and brought the total paid to States under the Hayden-Cartwright Act to $1,522,363. Funds paid to States during the fiscal year were as follows:

State:	*Amount*	State—Continued.	*Amount*
Colorado	$104, 518	New York	$311, 712
Kansas	317, 492	Oklahoma	3, 441
Maine	56, 563	Texas	96, 994
Nebraska	104, 817		
New Hampshire	53, 214	Total	1, 048, 751

TABLE 24.—*Flood-damage funds, available under section 3 of the Hayden-Cartwright Act, allotted to projects during the fiscal year 1937*

COMPLETED

State	Emergency-relief funds	Estimated total cost	Miles	State	Emergency-relief funds	Estimated total cost	Miles
Colorado	$206, 607	$384, 112	0. 5	New York	$347, 665	$775, 073	0. 4
Kansas	102, 424	204, 920	. 4	Oklahoma	3, 441	6, 974	. 4
Maine	66, 546	133, 091	. 1	Texas	148, 546	298, 960	1. 2
Nebraska	188, 422	379, 538	. 6				
New Hampshire	32, 427	64, 854	. 1	Total	1, 096, 078	2, 247, 522	3. 7

UNDER CONTRACT

Kansas	$295, 945	$591, 891	0. 6	Texas	$119, 930	$239, 860	0. 2
Maryland	105, 319	210, 639	. 2	Vermont	47, 550	95, 100	2. 4
New Hampshire	48, 949	97, 899	. 1				
New York	134, 450	315, 100	. 2	Total	881, 057	1, 808, 316	26. 3
Ohio	128, 914	257, 827	22. 6				

APPROVED

Kansas	$110, 000	$220, 000	0. 2	Vermont	$45, 983	$106, 766	2. 2
Kentucky	17, 688	35, 376	. 7	Virginia	77, 181	154, 361	. 2
Maryland	68, 500	137, 000	. 1				
Ohio	64, 875	129, 750	1. 3	Total	384, 227	783, 253	4. 7

Including work completed in the previous fiscal year the total obligations to the end of the fiscal year total $5,870,000, leaving a balance of $4,130,000 for new projects.

WORK-RELIEF HIGHWAY PROJECTS

Work-relief highway projects, begun in the fall of 1933, to relieve distress in particular areas stricken by drought and a scourge of grasshoppers, have been continued since in areas needing special relief. Road work has been carried on by an arrangement under which the Public Works Administration has granted funds needed to pay materials and equipment costs, limited to not more than 30 percent of the total expenditure, and the labor has been supplied from relief rolls and paid first by the Federal Emergency Relief Administration and later by the Works Progress Administration.

Under this arrangement the Bureau of Public Roads, cooperating with the respective State highway departments, has assumed the responsibility of supervising the road work.

During the year 1,426 miles of work of this kind was completed, bringing the total to date to 5,969 miles, and at the close of the year work was under contract on 1,532 miles, as shown in table 25.

TABLE 25.—*Status of National-Recovery work relief projects*

State	Completed during year			State	Under contract at end of year		
	Federal funds	Total cost	Miles		Federal funds	Total cost	Miles
Kansas	$316,886	$1,169,642	274.8	Kansas	$45,513	$151,710	48.5
Minnesota	22,247	82,844	22.6	Minnesota	801,813	3,923,065	68.0
North Dakota	98,971	424,246	150.8	Oklahoma	570,000	1,900,000	442.7
South Dakota	681,330	2,964,642	977.6	Texas	1,664,935	5,575,618	972.8
Total	1,119,434	4,641,374	1,425.8	Total	3,082,261	11,550,393	1,532.0

LOAN-AND-GRANT HIGHWAY PROJECTS

The Public Works Administration has continued the policy of financing or aiding, by loans or grants or both, the construction of roads and bridges in a number of States. Projects of this kind are initiated by their sponsors with the Public Works Administration and, after agreement has been reached and funds allotted, are turned over to this Bureau for detailed administration of construction.

Work of this kind was begun in 1934 under the National Industrial Recovery Act and has been continued during the past 2 fiscal years with funds allocated under the authorization in the Emergency Relief Appropriation Act of 1935. By the close of the year, loans and grants of $51,637,887 had been made for specific projects 9,040 miles in length and estimated to cost $113,778,761. This represents a net increase during the year of 1,415 miles involving $12,436,906 of loan and grant funds and estimated to cost $31,321,178. Table 26 shows details by States.

TABLE 26.—*Status on June 30, 1937, of loan-and-grant Public Works projects transferred by the Public Works Administration to the Bureau of Public Roads for supervision and audit*

ALLOTMENTS FROM NATIONAL INDUSTRIAL RECOVERY ACT

State	Funds allotted by Public Works Administration			Mileage, estimated cost, and funds assigned to specific projects approved under Public Works Administration allotments				
	Tentative allotment by special board for Public Works	Allotment by contracts executed		Miles	Estimated total cost	Funds assigned		
		Grant	Loan			Grant	Loan	Other
Alabama	$70, 247. 99	$20, 617. 28	$49, 630. 71	6. 7	$70, 247. 99	$20, 617. 28	$49, 630. 71	
California	1, 310, 863. 65	1, 310, 863. 65		16. 4	4, 587, 135. 59	1, 310, 863. 65		$3, 276, 271. 94
Connecticut	1, 207, 595. 74	1, 207, 595. 74		68. 7	4, 825, 941. 10	1, 207, 595. 74		3, 618, 345. 36
Illinois	2, 427, 234. 19	2, 427, 234. 19		97. 6	8, 169, 818. 51	2, 385, 536. 78		5, 784, 281. 73
Indiana	200, 662. 04	200, 662. 04		34. 5	765, 293. 83	200, 662. 04		564, 631. 79
Iowa	307, 586. 75	307, 586. 75		823. 6	1, 061, 690. 12	307, 586. 75		754, 103. 37
Kansas	5, 119, 129. 85	1, 294, 129. 85	3, 825, 000. 00	413. 7	5, 828, 223. 97	1, 294, 129. 85	3, 825, 000. 00	709, 094. 12
Louisiana	269, 258. 33	88, 258. 33	181, 000. 00	47. 3	300, 515. 08	88, 258. 33	181, 000. 00	31, 256. 75
Maryland	5, 411, 866. 00	1, 411, 866. 00	4, 000, 000. 00	72. 2	5, 090, 357. 16	1, 408, 168. 25	3, 541, 100. 08	141, 088. 83
Massachusetts	1, 702, 395. 00	1, 702, 395. 00		105. 1	5, 449, 602. 94	1, 616, 939. 64		3, 832, 663. 30
Michigan	10, 000. 00	10, 000. 00		29. 0	39, 818. 00	10, 000. 00		29, 818. 00
Minnesota	1, 368, 671. 72	983, 671. 72	385, 000. 00	477. 0	2, 874, 823. 53	841, 377. 91	301, 280. 40	1, 732, 165. 22
Mississippi	569, 286. 00	169, 286. 00	400, 000. 00	80. 1	498, 232. 11	149, 469. 62	348, 762. 49	
Missouri	1, 026, 000. 00	1, 026, 000. 00		50. 7	3, 780, 944. 30	1, 023, 181. 94		2, 757, 762. 36
Montana	1, 829, 000. 00	579, 000. 00	1, 250, 000. 00	697. 8	1, 955, 462. 56	579, 000. 00	1, 250, 000. 00	126, 462. 56
Nebraska	11, 500. 00	11, 500. 00		59. 5	40, 120. 22	11, 500. 00		28, 620. 22
New York	736, 814. 48	375, 033. 67	361, 780. 81	30. 9	1, 282, 140. 00	375, 033. 67	361, 780. 81	545, 325. 52
Ohio	793, 179. 87	139, 877. 63	653, 302. 24	27. 2	495, 847. 75	139. 877. 63	153. 302. 24	202, 667. 88
South Carolina	76, 082. 97	21, 283. 31	54, 799. 66	28. 1	76, 082. 97	21, 283. 31	54, 799. 66	
Texas	1, 471, 020. 71	931, 420. 71	539, 600. 00	238. 3	3, 254, 907. 27	931, 420. 71	539, 600. 00	1, 783, 886. 56
Washington	2, 282, 447. 21	2, 282, 447. 21		1, 275. 1	8, 139, 4 9. 56	2, 273, 293. 68		5, 866, 115. 88
West Virginia	2, 000, 000. 00	2, 000, 000. 00		447. 4	6, 608, 307. 64	1, 973, 037. 39		4, 635, 270. 25
Wisconsin	454, 300. 00	146, 271. 62	308, 028. 38	86. 4	526, 176. 96	146, 271. 62	308, 028. 38	71, 876. 96
Total	30, 655, 142. 50	18, 647, 000. 70	12, 008, 141. 80	5, 213. 3	65, 721, 099. 16	18, 315, 105. 79	10, 914, 284. 77	36, 491, 708. 60

TABLE 26.—*Status on June 30, 1937, of loan-and-grant Public Works projects transferred by the Public Works Administration to the Bureau of Public Roads for supervision and audit*—Continued

ALLOTMENTS FROM EMERGENCY RELIEF APPROPRIATION ACT OF 1935

State	Funds allotted by Public Works Administration			Mileage, estimated cost, and funds assigned to specific projects approved under Public Works Administration allotments				
	Tentative allotment by special board for Public Works	Allotment by contracts executed		Miles	Estimated total cost	Funds assigned		
		Grant	Loan			Grant	Loan	Other
California	$58, 854. 00	$58, 854. 00		0. 4	$130, 787. 00	$58, 854. 00		$71, 933. 00
Colorado	3, 000, 000. 00	3, 000, 000. 00		120. 7	4, 001, 210. 02	1, 799, 601. 00		2, 201, 609. 02
Florida	72, 424. 00	72, 424. 00		. 6	145, 239. 00	65, 357. 56		79, 881. 44
Illinois	594, 490. 23	594, 490. 23		114. 1	1, 402, 025. 69	594, 490. 23		807, 535. 46
Iowa	402, 732. 74	402, 732. 74		735. 6	759, 595. 49	330, 188. 02		429, 407. 47
Kansas	14, 463. 00	14, 463. 00		. 6	30, 832. 00	13, 874. 40		16, 957. 60
Maryland	1, 000, 000. 00	1, 000, 000. 00		27. 2	1, 930, 211. 27	868, 595. 06		1, 061, 616. 21
Michigan	119, 435. 00	119, 435. 00		16. 5	305, 823. 11	119, 435. 00		186, 388. 11
Minnesota	158, 823. 00	158, 823. 00		69. 3	347, 395. 34	153, 309. 21		194, 086. 13
Mississippi	23, 739, 850. 14	15, 089, 850. 14	$8, 650, 000. 00	1, 306. 0	28, 223, 316. 07	12, 693, 643. 64		15, 529, 672. 43
Missouri	396, 699. 54	396, 699. 54		364. 5	881, 689. 86	396, 699. 54		484, 990. 32
Nebraska	6, 611. 95	6, 611. 95		18. 0	14, 914. 82	6, 611. 95		8, 302. 87
New Jersey	31, 779. 00	31, 779. 00		3. 0	70, 620. 00	31, 779. 00		38, 841. 00
New York	212, 994. 48	212, 994. 48		28. 7	518, 703. 11	212, 994. 48		305, 708. 63
Ohio	754, 045. 79	360, 599. 04	393, 446. 75	229. 5	808, 134. 90	356, 924. 59	$388, 955. 21	62, 255. 10
Pennsylvania	423, 552. 00	423, 552. 00		2. 7	739, 808. 00	332, 913. 60		406, 894. 40
South Carolina	714, 090. 00	481, 090. 00	233, 000. 00	217. 0	950, 827. 90	426, 170. 03	218, 985. 88	305, 671. 99
Texas	2, 848, 838. 00	2, 358, 838. 00	490, 000. 00	341. 9	4, 838, 370. 76	2, 086, 311. 42	490, 000. 00	2, 262, 059. 34
Utah	45, 900. 00	45, 900. 00		29. 1	113, 237. 37	45, 900. 00		67, 337. 37
Washington	735, 592. 14	735, 592. 14		201. 5	1, 844, 920. 20	716, 902. 75		1, 128, 017. 45
Total	35, 331, 175. 01	25, 564, 728. 26	9, 766, 446. 75	3, 826. 9	48, 057, 661. 91	21, 310, 555. 48	1, 097, 941. 09	25, 649, 165. 34

NATIONAL FOREST ROAD CONSTRUCTION

The national forests in several States are very extensive. They are interposed between centers of population. The State routes, and the Federal-aid and United States highways superimposed on them, must traverse forest areas and are coincident with a large part of the forest-highway system. The approved forest-highway system includes over 20,000 miles, of which 37 percent are on the Federal-aid system and over 38 percent are parts of State routes not included in the Federal-aid system, leaving only about 25 percent of the highways not included in general-use road systems.

Forest-highway development has closely paralleled that of State highways in the States in which the national forests are located. Early activities consisted primarily of grading, draining, and surfacing with local materials such as clay-bound gravel and crushed stone or gravel. Constant increase in traffic has required the placing of more and more crushed-stone surfacing. Dusty surfaces are no longer tolerated by motorists and both new and old surfaces have been given some form of bituminous treatment.

Construction of forest roads has been followed by recreational use and traffic generated by the development of resources in and adjacent to the forests to a much greater extent than was anticipated when the work was begun. The resulting benefits have been clearly demonstrated and the system has been considerably expanded—3,000 miles in the last year. Much of this expansion has been in newly acquired forest areas, particularly in the Eastern States.

The broad, smooth-surfaced forest highways that now accommodate transcontinental and inter-State traffic in the Western States and millions of tourists seeking recreation among scenic surroundings in both Eastern and Western States are as superior to the pioneer roads that first penetrated forest areas as present-day motor vehicles are to those of the earlier day. Forest roads are being located and built so as to preserve the scenic beauties of the forests, construction scars are removed by sodding, seeding, and placing checks on washes. Methods are being developed to control erosion on slopes. Aesthetic features are preserved and emphasized as a part of construction operations. For the convenience of traffic, mountain passes on transcontinental routes through the forests are kept free of snow.

The two principal classes of forest roads are designated, respectively, forest highways and forest-development roads. The latter, as the name implies, serve primarily for the development of the forests; the former are roads of a higher order of traffic importance, generally those joining sections of the Federal-aid or State highway systems outside of the forests, or important community-service roads requiring improvement generally more expensive than that required on forest-development roads.

In the main, the work supervised by the Bureau is limited to the construction of forest highways; forest-development road work is generally administered by the Forest Service. But, while this definition of the work of the two Bureaus is approximately correct, the exact line of separation is drawn between what are termed major and minor projects. Major projects, administered by the Bureau, include all projects in the forest-highway system except those that do not require the technical services of a highway-engineering organization or those having an estimated average cost of less than $2,000 per mile. Those forest-development road projects of estimated average cost greater than $5,000 per mile and those requiring technical services are also classed as major projects.

Forest-road work has been carried on in recent years under authorizations of $10,000,000 for each of the fiscal years 1935–37 and $14,000,000 has been authorized for each of the fiscal years 1938–39.

Highways costing $7,014,890 were completed during the year and projects estimated to cost $7,715,691 were placed under construction. At the close of the year $6,208,594 was involved in work under construction, $3,074,158 in maintenance and surveys, $9,087,439 was available for new projects, and $411,850 for miscellaneous items.

Near the end of the year the Agricultural Appropriation Act appropriated $5,500,000, this being the unappropriated balance of the authorization for the fiscal year 1937, and also $7,000,000 of the $14,000,000 authorized for the fiscal year 1938.

In accordance with requirements of the governing rules and regulations a system of forest highways has been designated by concurrent action of the several State highway departments, the Forest Service, and this Bureau and approved by the Secretary of Agriculture. Also, as required by the rules and regulations, the highways constituting this system have been classified as follows:

Class 1. Forest roads forming sections of the Federal-aid highway system, either wholly within or, when so designated by the Forester and the Chief of the Bureau of Public Roads, partly without and adjacent to the national forests.

Class 2. Forest roads, not of class 1, which are parts of approved State highway systems, when so designated by the Forester and the Chief of the Bureau of Public Roads.

Class 3. All other forest roads of primary importance to counties or communities.

The roads which, according to these definitions, had been classified as forest highways had an aggregate length on June 30, 1937, of 20,255 miles, classified as shown in table 27.

TABLE 27.—*Classification of the mileage of the forest-highway system at end of fiscal year 1937*

	Class 1	Class 2	Class 3	Total		Class 1	Class 2	Class 3	Total
Western:	*Miles*	*Miles*	*Miles*	*Miles*	Eastern—Cont.	*Miles*	*Miles*	*Miles*	*Miles*
Alaska			378.8	378.8	Maine			11.0	11.0
Arizona	323.5	288.2	448.3	1,060.0	Michigan	466.7	283.8	274.4	1,024.9
California	617.9	1,302.0	528.2	2,448.1	Minnesota	179.4	217.8	207.4	604.6
Colorado	533.0	1,163.0	94.0	1,790.0	Mississippi	32.0	13.0	69.7	114.7
Idaho	721.2	165.3	191.5	1,078.0	Missouri	426.2	160.1	247.3	833.6
Montana	666.0	286.8	231.0	1,183.8	Nebraska			28.8	28.8
Nevada	104.7	282.4	73.4	460.5	New Hampshire	40.9	92.1	41.7	174.7
New Mexico	164.0	518.0		682.0	North Carolina	102.0	105.3	48.3	255.6
Oregon	718.5	344.8	304.4	1,367.7	Oklahoma	31.5		70.5	102.0
South Dakota	227.0		86.0	313.0	Pennsylvania	134.0	250.9	39.0	423.9
Utah	191.4	471.4	67.2	730.0	Puerto Rico			21.0	21.0
Washington	401.8	123.1	246.8	771.7	South Carolina		26.0	27.0	53.0
Wyoming	387.3	37.0	217.7	642.0	Tennessee	131.6	133.6	80.2	345.4
Total	5,056.3	4,982.0	2,867.3	12,905.6	Texas			35.0	35.0
Eastern:					Vermont	32.7	43.2	58.6	134.5
Alabama	4.0		31.0	35.0	Virginia	79.0	127.9	210.0	416.9
Arkansas	274.6	310.3	44.6	629.5	West Virginia	137.0	182.0	62.0	381.0
Florida	39.7	134.9	36.3	210.9	Wisconsin	85.7	177.0	206.9	469.6
Georgia	92.0	54.8	58.5	205.3	Total	2,588.8	2,767.6	1,992.8	7,349.2
Illinois	192.7	27.5	48.7	268.9					
Kentucky	41.0	58.0	13.0	112.0	Grand total	7,645.1	7,749.6	4,860.1	20,254.8
Louisiana	66.1	369.4	21.9	457.4					

During the year improvements were completed on 139 miles of the forest-highway system, exclusive of work done in further improving surfaces previously placed, bringing the total mileage improved to date with Federal funds to 6,592.7 miles. Of the mileage improved during the year, 108.6 miles were in the Western States and Alaska, and the remaining 30.4 miles were in the forests of 19 Eastern States. Of the total mileage improved to date, 5,983.2 miles are in the West and 609.5 miles are in the East.

The mileage of forest highways completed during the year and to date, by States, is shown in table 28.

TABLE 28.—*Mileage of forest highways completed during the fiscal year and total completed to June 30, 1937*

State	During 1937	Total to June 30, 1937	State	During 1937	Total to June 30, 1937
Western:	*Miles*	*Miles*	Eastern—Continued	*Miles*	*Miles*
Alaska		240.9	Georgia		21.0
Arizona	10.0	570.4	Illinois	3.2	4.7
California	12.2	784.1	Kentucky	.1	.1
Colorado	15.0	532.2	Michigan	7.2	50.5
Idaho	18.0	687.9	Minnesota		113.0
Montana		595.0	Missouri		8.1
Nevada	16.1	173.8	Nebraska		8.7
New Mexico		304.8	New Hampshire	12.0	25.2
Oregon	19.1	999.3	North Carolina		50.9
South Dakota		61.2	Oklahoma		16.1
Utah	5.5	352.2	Pennsylvania	2.1	9.2
Washington	6.8	322.8	South Carolina		15.6
Wyoming	5.9	358.6	Tennessee	2.3	47.4
			Virginia		22.9
Total	108.6	5,983.2	West Virginia	2.5	8.7
Eastern:			Wisconsin	1.0	15.7
Alabama		5.1	Total	30.4	609.5
Arkansas		125.0			
Florida		61.6	Grand total	139.0	[1] 6,592.7

[1] Changes in forest highway system resulted in dropping from the system 12.7 miles of highway previously surfaced.

Tables 29 and 30 show the mileage of highways under construction and completed at the close of the fiscal year, segregated by types of construction and by States.

TABLE 29.—*Mileage of forest highways under construction, June 30, 1937*

State	Graded and drained	Traffic-bound surfaces of miscellaneous materials	Water-bound macadam	Bituminous surface treated	Low-cost bituminous mix	Bituminous macadam	Portland cement concrete	Bridges	Total
Western States:	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Alaska	0.9	15.9						0.5	17.3
Arizona	26.9	11.1		13.3					51.3
California	39.7	11.1		21.1	14.3			(1)	86.2
Colorado		2.2						(1)	2.2
Idaho	27.0	12.1			23.2			.2	62.5
Montana	16.7			21.5				(1)	38.2
Nevada	7.5			16.1					23.6
New Mexico		3.3							3.3
Oregon	9.7	7.8		23.2	37.1		0.2		78.0
South Dakota					7.1				7.1
Utah		6.5							6.5
Washington	11.8	1.2					.1		13.1
Wyoming	2.6	12.5							15.1
Total	142.8	83.7		95.2	81.7		.3	.7	404.4
Eastern States:									
Arkansas	.2	2.5						.1	2.8
Florida								.1	.1
Georgia								(1)	(1)
Kentucky								(1)	(1)
Michigan		6.3							6.3
Minnesota	11.8	3.0			6.8				21.6
Nebraska	6.5								6.5
New Hampshire			2.8					(1)	2.8
North Carolina		3.2							3.2
Oklahoma		.3							.3
Pennsylvania						1.5			1.5
South Carolina				.4					.4
Wisconsin	2.8								2.8
Total	21.3	15.3	2.8	.4	6.8	1.5		.2	48.3
Grand total	164.1	99.0	2.8	95.6	88.5	1.5	.3	.9	452.7

[1] Less than 0.1 mile.

TABLE 30.—*Completed forest highways by types, by States as of June 30, 1937*

State	Graded and drained	Sand-clay	Traffic-bound surfaces of miscellaneous material	Bituminous surface treated	Low-cost bituminous mix	Bituminous macadam	Portland-cement concrete	Bridges	Total
Western States	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Alaska	238.4							2.5	240.9
Arizona	216.1		290.3	24.6	15.4	23.3		.7	570.4
California	252.6		184.1	253.8	91.1			2.5	784.1
Colorado	153.6		229.0	32.8	116.6			.2	532.2
Idaho	297.3		289.6		98.8		.1	2.1	687.9
Montana	196.2		255.5	16.1	125.2			2.0	595.0
Nevada	44.3		51.4	16.1	61.9			.1	173.8
New Mexico	45.8		202.3	3.3	53.3			.1	304.8
Oregon	179.5		632.0	134.1	35.1	14.6	.1	3.9	999.3
South Dakota			47.7	5.9	7.6				61.2
Utah	134.4		166.2	22.1	28.9			.6	352.2
Washington	320.7							2.1	322.8
Wyoming	42.5		249.9	66.1				.1	358.6
Total	2,121.4		2,598.0	574.9	633.9	37.9	.2	16.9	5,983.2
Eastern States:									
Alabama			5.1						5.1
Arkansas	98.3		26.1					.6	125.0
Florida		4.3		26.6	29.8			.9	61.6
Georgia	11.0		9.9					.1	21.0
Illinois			4.7						4.7
Kentucky								.1	.1
Michigan			50.5					(1)	50.5
Minnesota	34.7	3.4	53.1	12.6	9.1			.1	113.0
Missouri			8.1						8.1
Nebraska	8.7								8.7
New Hampshire				25.1				.1	25.2
North Carolina	14.2		6.6	30.1				(1)	50.9
Oklahoma	.8		15.3					(1)	16.1
Pennsylvania				1.8		7.4			9.2
South Carolina				15.6					15.6
Tennessee			47.4						47.4
Virginia	3.5		2.3	10.6		6.5		(1)	22.9
West Virginia	2.5		2.6	3.6				(1)	8.7
Wisconsin	1.5		14.2						15.7
Total	175.2	7.7	245.9	126.0	38.9	13.9		1.9	609.5
Grand total	2,296.6	7.7	2,843.9	700.9	672.8	51.8	.2	18.8	6,592.7

[1] Less than 0.1 mile.

Recent construction has closed gaps in important State and Federal-aid highways and provided access to additional recreational areas.

Forest highways now nearing completion that will be important traffic arteries are: In Montana, the Yellowstone Trail and the Clark Fork Highway; in Oregon, the Willamette, the North Santiam, and the Columbia River Highways; in Washington, the Stevens Pass and the Randle-Yakima Highway; in Arizona, the Oak Creek and the Globe-Showlow Highways; in California, the Placerville-Lake Tahoe Highway, the Sonora Pass, and the Mount Shasta-Mount Lassen Highway; in Nevada, the Owyhee River Highway; in South Dakota, the Deadwood-Custer-Hot Springs Highway; in Idaho, the North and South Highway; and in Utah, the Alpine Scenic Highway.

ROAD CONSTRUCTION IN NATIONAL PARKS AND MONUMENTS

Funds are available to the National Park Service for the improvement of roads within and approaching national parks and monuments and for parkways. The Park Service selects roads for improvement with these funds and otherwise controls expenditures. Under an agreement of several years' standing surveys are made and construction is supervised by the Bureau of Public Roads.

Systems of roads within and leading to national parks and monuments have been designated for improvement with Federal funds by the Secretary of the Interior. Parkways are being provided to give access to parks or monuments or to become parts of more extensive national parkways that it is expected will be developed. All parkways pass through localities of scenic beauty or historic interest and consist of a road built according to high standards with the adjacent area under Federal control and free of commercial activity except such as may be authorized to accommodate motorists. Lands for parkways have been transferred to Federal control by States and private individuals.

During the year construction was completed on 169 miles of roads of these classes, making a total of 1,293 miles thus far improved. This does not include a considerable mileage of so-called stage-construction work consisting of surfacing roads formerly graded or widening and betterment work.

The mileage completed during the year and the total mileage completed at the close of the year are shown in table 31.

TABLE 31.—*Highways completed in or leading to national parks and monuments*

Park, monument, or parkway	Completed during 1937	Total to June 30, 1937	Park, monument, or parkway	Completed during 1937	Total to June 30, 1937
	Miles	*Miles*		*Miles*	*Miles*
Acadia		12.1	Lassen		35.1
Blue Ridge Parkway	50.5	50.5	Meriwether Lewis		1.9
Bryce Canyon		21.7	Mesa Verde		20.6
Carlsbad Caverns		8.4	Morristown	0.9	2.6
Chalmette	.5	.5	Mount Rainier	8.6	84.0
Chickamauga-Chattanooga	7.2	17.6	National Capital Parks	.4	5.3
Colonial	1.5	12.4	Petersburg	1.5	7.3
Crater Lake	4.3	57.9	Petrified Forest		26.3
Devil's Tower		.3	Rocky Mountain	8.3	51.4
Fort Donelson	2.8	2.8	Scotts Bluff	1.0	1.6
Fredericksburg-Spotsylvania	6.8	23.2	Sequoia		46.1
General Grant		6.4	Shenandoah		71.6
George Washington Birthplace		2.6	Shiloh	10.3	10.3
Gettysburg	.2	3.1	Vicksburg		4.8
Glacier	2.3	58.0	Wind Cave		15.9
Grand Canyon		162.1	Yellowstone	37.0	287.8
Great Smoky Mountains	11.2	22.9	Yosemite	12.2	98.5
Hawaii		35.6	Zion		18.7
Hot Springs		3.5	Total	169.1	1,293.0
Kill Devil Hill	1.6	1.6			

Work on national-park roads during the year consisted of grading pioneer roads, construction of tunnels, and placing of surfaces ranging from low to the highest types. Much work was done in widening previously constructed surfaces to meet the requirements of increasing traffic. There has been a general increase in traffic on all park roads, the upward trend continuing steadily over a period of years.

Numerous types of bituminous surface are used on national-park roads. Nearly all roads that have been surfaced with crushed rock or crushed gravel have had a light application of bituminous material to settle the dust and hold the surfacing material on the road. This may be followed by a heavier surface treatment, carpet coat, or a bituminous surface that is mixed in place on the road. Still higher types of surfaces used are the bituminous macadam and premixed bituminous concrete.

In the eastern parks most of the surfaces are either bituminous concrete or portland-cement concrete. Table 32 shows the mileage of roads completed to the end of the year by types.

TABLE 32.—*Highways completed in or leading to national parks and monuments at end of fiscal year 1937*

Park	Graded and drained	Gravel	Bituminous treatment	Bituminous mixture	Bituminous macadam	Bituminous concrete	Portland-cement concrete	Bridges	Total
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Acadia			4.2		7.9				12.1
Blue Ridge Parkway		50.5							50.5
Bryce Canyon				21.7					21.7
Carlsbad Caverns				8.4					8.4
Chalmette							0.5		.5
Chickamauga-Chattanooga				10.4			7.2		17.6
Colonial	2.7		.7				8.8	0.2	12.4
Crater Lake	4.1	18.6	1.9	26.4	6.8			.1	57.9
Devil's Tower								.3	.3
Fort Donelson				2.8					2.8
Fredericksburg-Spotsylvania			17.8	5.4					23.2
General Grant	6.4								6.4
George Washington Birthplace			2.6						2.6
Gettysburg				.8		2.3			3.1
Glacier	3.5	23.7	30.6					.2	58.0
Grand Canyon		.7	7.6	139.1	14.6			.1	162.1
Great Smoky Mountains	.2	3.4	15.3	4.0					22.9
Hawaii			10.6	9.0	16.0				35.6
Hot Springs			3.5						3.5
Kill Devil Hill				1.6					1.6
Lassen Volcanic			4.7	30.4					35.1
Meriwether Lewis				1.9					1.9
Mesa Verde				20.6					20.6
Morristown		2.6							2.6
Mount Rainier	27.1	28.8			27.8			.3	84.0
National Capital parks	1.2					4.0		.1	5.3
Petersburg	1.3		6.0						7.3
Petrified Forest				26.1				.2	26.3
Rocky Mountain		6.9	8.1	36.4					51.4
Scotts Bluff	1.6								1.6
Sequoia	6.3		14.3	25.4				.1	46.1
Shenandoah	6.2		12.6	52.8					71.6
Shiloh				3.7			6.6		10.3
Vicksburg		.1				.1	4.6		4.8
Wind Cave				15.9					15.9
Yellowstone		48.8	115.3	123.2				.5	287.8
Yosemite	25.6		26.3	16.1	14.0	10.0	6.2	.3	98.5
Zion				17.6			1.0	.1	18.7
Total	86.2	184.1	282.1	599.7	87.1	16.4	34.9	2.5	1,293.0

Bureau activities during the year were continuous in parks and monuments throughout the country. Such parks and monuments as Chalmette, Fort Donelson, Kill Devil Hill, and Shiloh, appear in the list of completed work for the first time. Road construction is also under way in several new parks and monuments.

Road construction in the western park areas has been concentrated on closing of gaps on important routes of the park systems. An outstanding example of this development is the Big Oak Flat Road in Yosemite National Park. Located on the north side of Yosemite Valley and opposite the famous Wawona tunnel and road, this road when completed, will afford a more direct route to the park to traffic coming from the San Francisco district. It leaves the Floor of Valley Road and winds up the side of the mountain to the top where it meets the Tioga Road at Crane Flat and thence leaves the park on U. S. 120 to San Francisco. The Big Oak Flat Road represents difficult mountain construction and excavation on this highway is mostly hard granite. Two short tunnels and one long tunnel are under construction at an estimated cost of approximately $800,000.

Construction of the Tioga Road is progressing, but a large gap remains to be completed. It is a superb mountain highway through some of the most rugged of the high Sierras, crossing this mountain range at Tioga Pass, at an elevation of nearly 10,000 feet.

In Crater Lake National Park activities have been concentrated on completing the loop around the lake. About 30 miles of the Rim Road are complete and 5 miles are under construction. Funds are available for the completion of the remaining 4-mile gap.

Work is also progressing rapidly on the Stevens Canyon and East Side Highways in Mount Rainier National Park. When completed, these roads will connect Paradise Inn on the west side of the park with the White River area on the east side of the park. When these roads are completed it will be possible for the tourist to drive more than halfway around the famous mountain that gives the park its name.

In Glacier National Park work is progressing on the west side section of the Transmountain Highway. This work consists of widening and improving the road between Belton and Avalanche Creek to the standard of width and surface on the east side of Logan Pass which was completed some time ago.

Landscape work and roadside improvement to heal all construction scars and develop aesthetic features are a primary requirement on all national-park construction. An example of this work is the staining of cliffs on sections of the Walnut Canyon Road to make them more closely resemble the weathered sections which were not disturbed in the construction. The results obtained were highly satisfactory.

In the East the most important development is the rapid progress being made on the parkway program. During the past year about 50 miles of the Blue Ridge Parkway was completed, and about 85 miles was under construction at the end of the year. This parkway, approximately 480 miles in length, is an extension of the Skyline Drive in Shenandoah National Park and follows closely the crest of the Blue Ridge Mountains through Virginia and North Carolina to the Great Smoky Mountains National Park. The Skyline Drive in Shenandoah National Park has one uncompleted gap about 9 miles in length in its entire length of approximately 100 miles. Funds are expected to be provided in the 1938 program for completion of this gap.

Another eastern parkway is the Natchez Trace between Natchez, Miss., and Nashville, Tenn., through Mississippi, Alabama, and Tennessee. This old trail, approximately 460 miles in length, was laid out under a treaty with the Indians in 1801 and was used as a pioneer road between Natchez and Nashville. Just before the end of the year three contracts were let for a length of about 34 miles of this parkway in Mississippi. It is expected that rapid progress will be made on the parkway in the next fiscal year.

Table 33 shows the park and monument highways under construction at the close of the year segregated by types of construction. Most of this work consists of further improvement of roads previously improved.

TABLE 33.—*Highways under construction in or leading to national parks and monuments at end of fiscal year 1937, by types*

Park	Graded and drained	Gravel	Bituminous treatment	Bituminous mixture	Bituminous macadam	Bituminous concrete	Portland-cement concrete	Bridges	Total
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Acadia			2.9					0.1	3.0
Blue Ridge Parkway		83.4						.1	83.5
Crater Lake	5.3								5.3
Fort Matanzas				0.5					.5
Fort Pulaski								.3	.3
Fredericksburg-Spotsylvania						0.2			.2
General Grant	4.0								4.0
Gettysburg						3.8			3.8
Glacier	16.4		3.5	18.6				.1	38.6
Grand Canyon			31.9	8.6					40.5
Guilford Court House				2.6					2.6
Lassen				4.7					4.7
Mesa Verde				31.0					31.0
Mount Rainier	5.7	7.8		24.1				.1	37.7
Natchez Trace	34.1								34.1
National Capital parks			.4					.1	.5
Petrified Forest			4.8						4.8
Rocky Mountain				8.5					8.5
Scotts Bluff							1.6		1.6
Shenandoah		21.6							21.6
Vicksburg								.1	.1
Yellowstone	10.0	13.0	13.7	17.8				.1	54.6
Yosemite	7.7			11.6				.1	19.4
Total	83.2	125.8	57.2	128.0		4.0	1.6	1.1	400.9

The mileage of approach roads completed, under construction and approved for construction is reported in table 34.

TABLE 34.—*Location and length of approach roads to national parks and monuments*

Road	Park	Approved for construction	Completed	Under construction
		Miles	*Miles*	*Miles*
Fresno-General Grant	General Grant	3.6		3.9
Cameron-Desert View	Grand Canyon	28.1	28.1	
South Approach	do	52.3	52.3	
Jacobs Lake-North Rim	do	31.2		31.2
Mineral-Lassen	Lassen	8.8	[1] 4.1	4.7
Sequoia-General Grant	Sequoia-General Grant	13.5	13.5	
Custer-Wind Cave	Wind Cave	8.6	8.6	
Southwest Approach	Yellowstone	13.9	13.9	
Moran-Yellowstone	do	24.0	5.9	
Red Lodge-Cooke City	do	59.6	59.6	
East Approach	do	23.0		13.8
Zion-Bryce Canyon	Zion-Bryce Canyon	35.0		
Total		301.6	186.0	53.6

[1] Completed as a forest-highway project.

At the close of the year the total park-road work completed amounted to approximately $50,800,000. Work under construction is estimated to cost approximately $17,350,000. Additional construction is planned that is estimated to cost $1,900,000.

INTER-AMERICAN HIGHWAY

Work on the Inter-American Highway has continued with increased momentum during the year. Impassable gaps have been reduced to about 560 miles. The building of this highway through Central America to Panama City is important to the United States politically, socially, and economically. Politically, it cements the friendship between the United States, Mexico, the republics of Central America, and Panama, so important to the welfare of all. Socially, it will educate Americans in totally different ancient and tropical civilizations, and give them a new field for vacationing and touring.

But economically, the benefits are greatest of all; for efficient communication with Central America will bring us a new market for our manufactures and natural products and, at the same time, supply us with tropical products, such as bananas and other fruits, coffee, rice, sugar, drugs, oils, rubber, spices, and various useful plants, as well as with hardwoods, like mahogany, and minerals and semiprecious stones. Development of these resources and commerce awaits only transportation; and the present year has removed many of the worst obstacles on this highway and construction is proceeding rapidly on different important projects along the route.

Cooperation with the countries to the south in furtherance of the Inter-American Highway began under congressional authorization in 1928. The first substantial contribution by the United States toward a highway was the completion of a reconnaissance survey in 1933, made by the Bureau at the request of the Department of State. The report, issued in 1934, describes a feasible route extending from Nuevo Laredo on the Texas border to Mexico City and the southern border of Mexico, thence along the Pacific slope through Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, to Panama City in Panama. It passes through the capital of each country excepting Honduras, which has a connecting road to the capital.

During the year the United States has assisted in the construction of bridges that remove major obstacles to development of the route. This was made possible by the authorization of $1,000,000 made in 1934 for cooperation in the survey and construction of the highway. Under cooperative agreements with three of the Central American republics, materials, machinery, and technical direction are being supplied for the construction of nine bridges and labor and local materials are being supplied by the countries concerned. Fabricated steel is being supplied for two additional bridges in Panama. The Government of Panama will build the necessary piers and abutments and erect the bridges.

In addition to these bridges there are being built or planned under the present appropriation, a 25-mile section of road between Cartago and San Marco in Costa Rica, a 15-mile section between Tipitapa and Las Maderas River in Nicaragua, and another 15-mile section between Asuncion Mita in Guatemala and the frontier of El Salvador. Equipment and materials for culverts are being furnished by the United States.

The three largest bridges being built, the Tamazulapa in Guatemala, the Chiriqui in Panama, and the Choluteca in Honduras, are practically completed. Contracts have been let for the Amatal and Tahuapa Bridges in Guatemala, the Platanar Bridge in Panama, and the Rio Grande, Esteli, and Maderas Bridges in Nicaragua, all of which are expected to be completed within a few months. The structural steel has been delivered from the United States to Panama and is in storage there for the Chirigaqua and San Cristobal Bridges, that are to be built by the Panama Government after the rainy season.

The Republic of Panama, in return for assistance in bridge construction has agreed to complete the route in that Republic in the immediate future. The Governments of Honduras, El Salvador, and Guatemala are making excellent progress on sections of the highway. The section of the highway from the Texas border to Mexico City, completed last year by Mexico, is already carrying a large volume of tourist and business traffic and is an indication of what may be expected when the entire route is completed.

The total length of the highway will be 3,250 miles. The present condition is as follows: 1,265 miles of all-weather roads, mostly paved or being paved (including 765 miles from Nuevo Laredo to Mexico City and 300 miles from Panama City to David, both important to the United States as contiguous to Texas and the Canal Zone); 1,425 miles of dry-season roads, mostly impassable during the rainy season; and 560 miles of trails, impassable to wheeled vehicles at any time.

TRANSPORTATION, ECONOMIC, AND STATISTICAL INVESTIGATIONS

HIGHWAY-PLANNING SURVEYS

By the Hayden-Cartwright Act of 1934 and subsequent legislation the Secretary of Agriculture is authorized to approve allotment of not to exceed 1½ percent of the amount of Federal highway funds apportioned for any year to be used for surveys, plans, and engineering and economic investigations of projects for future construction.

Realizing the need of facts of many kinds as a basis for the planning of future construction programs in all States, the Bureau in 1935, proposed that the expenditure thus authorized be devoted to the conduct of comprehensive fact-finding surveys. The proposal has since been adopted by one State after another and the State-wide, highway-planning surveys, as they are called, are now in progress in all States with the exception of Connecticut, Delaware, Mississippi, New Jersey, and New York.

The surveys consist of a number of related studies the object of which is to determine the present state of the whole rural highway system, to rate the service rendered by all parts of the system, and to make possible a selection of that part of the whole system which, by reason of its relative importance and absolute utility, merits inclusion in future improvement plans. The surveys also aim to assemble the facts necessary for an estimate of the ultimate cost of building and maintaining the economically necessary improved highway system; and finally to make possible the establishment of a definite, economically, and socially defensible, integrated highway-improvement program in all States.

In order that the facts shall be collected in the various States on a comparable basis, all the surveys follow a general plan developed by the Bureau, which has assigned to each State a representative to maintain contact between the Bureau and the State survey organization.

Field work on three phases of the surveys (road inventory, traffic surveys, and financial and road-use surveys) has been practically completed in most of the States. The field work of the road inventory, by means of which complete records of all existing roads will be obtained, together with a determination of their conditions and the property they serve, has been completed in 31 States in which there is an aggregate road mileage of 2,035,067. In 9 States, with an estimated road mileage of 598,151, the mileage inventoried up to June 30 was 468,962. County base-map tracings are being prepared as a basis for State maps which will for the first time give a complete picture of our road system. Of the county base

maps for the 40 States, 13.5 percent were complete, and an additional 20.5 percent were under way at the end of the year.

The States which have completed the field work on the traffic survey and the financial and road-use surveys are now tabulating and analyzing the great mass of data that has been collected. The traffic surveys have produced information as to the character and volume of traffic on each section of highway, from which the relative importance of each highway may be determined. In the financial and road-use surveys studies have been made of the sources of highway revenue, the purposes for which it is spent, the extent to which rural and urban residents contribute to the cost of each class of road, and the amount of benefit they derive by travel upon each class.

The surveys also include a determination of the life of surfaces, grades, and structures built on the State highway systems in the past, so far as the records permit, to the end that a more dependable estimate may be made of the average term over which future capital investments must be amortized.

At all grade crossings of highways and railroads the facts of physical condition and density of rail and highway traffic are being determined to facilitate establishment of a priority list of crossings to be abolished or protected. At selected places other studies are being made to determine the ability of motortrucks and tractor-trailer combinations to surmount grades of various steepness in order to ascertain what needs to be done to alter the present designs of highway or vehicles, or both, to prevent slow-moving freight vehicles from obstructing other traffic.

SAFETY RESEARCH

Under authority of the act approved June 23, 1936, a series of research projects in highway safety was conducted, in cooperation with the Highway Research Board of the National Research Council. Particular attention was given to three phases of the problem:

1. Uniformity of State motor-vehicle laws.
2. Improvement of basic data, particularly accident reporting needed for the study of accident causes and prevention.
3. The characteristics and habits of drivers, including the identification of dangerous drivers.

A preliminary report was made to Congress on March 23, 1937, and a final report was nearing completion at the close of the year. The report will recommend—

1. That appropriate steps be taken to effect greater uniformity of motor vehicle and traffic laws, especially in essential details. Diverse traffic regulations make the driver who has formed his driving habits in one locality a frequent though involuntary lawbreaker when he leaves his own community.
2. That uniform minimum standards be developed for methods of obtaining facts regarding the occurrence of accidents and the attendant circumstances, and for methods of analysis that will more exactly recognize and interpret the facts.
3. That a careful study be made of inspectional services as a means of assuring safe condition of cars in operation. Since many drivers do not know the limitations of their vehicles or of their own sensory reactions, it is of paramount importance that brakes and lights, at least, be kept in first-class condition.
4. That studies be made to determine whether and to what extent highway-patrol organizations may be expanded to advantage.
5. That further continued research be made in several lines related to highway safety.

The possibility of identifying applicants for drivers' licenses who are liable to come within the accident-prone class of drivers has been given limited study, and this highly important work should be continued.

MAINTENANCE COST STUDIES

Agreements with the State Highway Departments of Connecticut, New Hampshire, and Rhode Island for a study of highway-maintenance costs in relation to traffic volume were renewed for the third year. Traffic records were obtained for 31 sections of highway in Connecticut, 52 sections in New Hampshire, and 102 sections in Rhode Island. A detailed inventory of all these sections was nearly completed. Detailed maintenance costs on the same sections are being kept by the States.

The objective of this study is to determine highway costs for different types of road surface in relation to traffic carried. Due to certain nonperiodic or infrequent items of maintenance cost no conclusions can be attempted until the records have been kept for a period of at least 5 years.

TRAFFIC-CAPACITY STUDIES

Studies of the speed of vehicles in relation to traffic density and highway capacity were continued. Analysis of available traffic records raised many questions which require additional field data for their solution, and arrangements were made for securing these through the highway planning survey organization.

Typical questions are: Can we conceive of the absolute capacity of a highway or must capacity be defined in terms of speed? How are capacity and congestion related? What is congestion? How do individual vehicle-speed differences affect capacity?

NATIONAL CONFERENCE ON STREET AND HIGHWAY SAFETY

The Bureau continued its cooperation with the executive committee of the National Conference on Street and Highway Safety. Copies of the Uniform Vehicle Code and other literature prepared by the conference were widely distributed to legislative promotional groups and others. The pamphlet Guides to Traffic Safety, originally prepared by the executive committee of the conference in 1934, was revised and reissued by the Bureau. Plans were made for a second printing of the Manual on Uniform Traffic Control Devices for Streets and Highways, prepared in 1935 by a joint committee representing the National Conference on Street and Highway Safety and the American Association of State Highway Officials.

AMERICAN ASSOCIATION OF MOTOR VEHICLE ADMINISTRATORS

The Bureau has actively cooperated in the work of the American Association of Motor Vehicle Administrators, which has undertaken an intensive research and educational program to advance uniformity in legislation, reciprocity, and highway safety. To the association belongs a fair share of the credit for the enactment in 1937 of what is probably the largest number of uniform traffic laws ever adopted by the States in a single year. Under an agreement with the association, a member of the Bureau staff is serving as its executive secretary.

ESTIMATING HIGHWAY TRAFFIC VOLUME

Further studies have been made toward a solution of the problem of traffic sampling. Estimates of highway traffic based on a variety of schedules of sample counts have previously been compared to determine the most efficient schedules, considering both cost and reliability of results. During the year attention has been given to hourly, daily, and seasonal variations, in relation to reliability of estimates. The results of the earlier studies were reported at the annual meeting of the Highway Research Board in November 1936.

RAILROAD-LINE ABANDONMENT STUDIES

During the year the records, since 1920, in the proceedings before the Interstate Commerce Commission for certificates of convenience and necessity permitting the abandonment of the whole or portions of railroads to the number of 1,088 were examined and statistical data abstracted from them. These cases included the abandonment of 16,734 miles of railroad. The statistical data abstracted consisted principally of the mileage involved in each case; the investment in property; population affected; passengers and commodities carried; high and low tonnage and operating deficits for the last 5 years of operation; the purpose for which the lines were originally constructed; causes leading to their abandonment; and other pertinent data. These data relate to cases in California, Kansas, Michigan, Pennsylvania, and Wisconsin.

The purpose of this study is first to develop the pattern of railroad abandonments in each State, especially in its relation to the pattern of heavy-duty rails or main lines; then to establish a significant series of surrounding characteristics like population density, traffic density (passenger and freight), operating income or deficit exhibited by the lines abandoned, particularly when highway competition has been a principal or contributing cause. With such a series of gages available, it will next be possible to examine the probable trend of future abandonments, and the extent to which highway planning must take account of the eventual substitution of highway transport for branch-line feeders of the railroads.

HIGHWAY-MANAGEMENT AND PRODUCTION COST STUDIES

For a number of years the Bureau has conducted field studies of the efficiency of methods of highway construction. Detailed time studies were made of each operation in grading and in constructing the various types of surface. These data were analyzed to set up standards against which a contractor might compare his own operations and determine their efficiency.

While the Bureau was administering a greatly enlarged program of emergency highway construction the personnel engaged in efficiency studies was drawn upon to a considerable extent for special assignment on emergency work, particularly to collect data on highway employment and to analyze the data collected.

The production-cost studies thus interrupted were resumed during the year and on completion of current studies this work will be concluded.

PHYSICAL RESEARCH

For a number of years the research work of the Bureau has been carried on principally at the research station of the Department at Arlington, Va. It has been known that the land occupied would eventually be taken for other Government use and this has precluded the construction of permanent laboratories or undertaking experiments requiring a fixed location for a period of years.

This situation is now to be corrected by the construction of a permanent research station at Abingdon, Va. on the Mount Vernon Memorial Highway, 2 miles from Washington. Plans have been completed for laboratories that will adequately house the testing and research work of the Bureau and there is ample space for outdoor testing work. Funds authorized in 1931 and in 1934 have been partly used for purchase of land and preparation of plans. Remaining funds with additional authorizations made during the last session of Congress are sufficient to complete the buildings. Bids will be called for and work begun early in the new fiscal year.

SUBSURFACE EXPLORATION

Previous reports have described two methods developed by the Bureau of determining the distance from the ground surface to rock—an important matter in selecting locations for highways and bridges. In the seismic method the distance is determined by exploding blasting caps in the ground, measuring the time of travel through the ground of resulting sound waves, and making suitable calculations. In the resistivity method, measurements are made of the resistance to transmission of electrical currents through the ground. Since the electrical resistance of rock is different from that of soil its presence can be detected and the distance below the surface calculated.

Studies of the application of these methods to various highway problems have been continued. During the year a fairly comprehensive series of tests were made with the seismic method in Oregon, Washington, and California, on highway projects where heavy grading was in progress or contemplated. Excavations at locations where tests were made are yielding information concerning the accuracy and general value of such explorations. Considerable interest in these demonstrations was manifested by those who witnessed them. The data obtained demonstrate the practicability of the application of the seismic method to field problems. Data obtained with the electrical-resistivity method in the same tests give added information concerning the utility and limitations of this method.

At the request of the Department of the Interior a proposed dam site in Montana was explored by the seismic method and arrangements have been made to cooperate with the War Department on similar work in some of the Eastern States.

Improvements have been made in both the seismic and the resistivity instruments and in the operating technique and field procedure.

MOTOR-VEHICLE IMPACT INVESTIGATIONS

Having established rather definitely the magnitude of the impact forces of vehicle wheels on pavements, all effort has been concentrated on the study of the elastic behavior of concrete when acted upon by comparable static and impact forces. The data furnished by the tests made provide fundamental information that is needed for the development of rational methods of pavement design. The work is necessarily slow and painstaking. With the special testing equipment designed and built for this research many thousands of observations have been made.

This research correlates with that which is being conducted to throw light on the design of both rigid and flexible road surfaces.

MEASUREMENT OF ROAD-SURFACE ROUGHNESS

Road smoothness is important to the comfort of every user of the highway and, because roughness creates impact, it has significance in the design and maintenance of surfaces. Many devices have been proposed for measuring in some way this important property. Probably the most widely used is one developed by the Bureau a number of years ago, a mechanical device attached to the front axle of an automobile and recording vertical movement in figures on a dial on the dashboard. In its present form the device has certain recognized weaknesses. The efforts toward its improvement, mentioned in last year's report, are being continued. A new model has been designed and will be built for study.

INVESTIGATION OF CONCRETE-PAVEMENT DESIGN

This comprehensive research into the structural action of concrete-pavement slabs has been described in preceding annual reports. During the year a fourth report has been published. This report concerns the structural action of joints. It has stimulated a widespread interest in the design of this important feature of concrete pavements, and, as a result, many new designs are being developed in an effort to apply the principles suggested by this research. The extent to which the information made available by these reports is being studied and put to practical use by those interested in better pavement design is most encouraging. The final major report on this investigation is nearing completion.

This research indicated the necessity for short slabs for the proper control of stresses in plain concrete pavements. Short slabs mean frequent transverse joints and because of the cost and difficulties of installation of such joints there is some reluctance to adopt short slabs as standard design. Through the proper use of steel reinforcement it may be possible to increase the distance between constructed joints and still maintain a control over pavement stresses and the Bureau has planned an experimental project, in cooperation with the Indiana Highway Commission, in which this possibility will be investigated. Arrangements are being made to place various amounts of steel in slabs of various lengths in a regular paving project. Observations of the structural behavior of these sections in service should indicate the extent to which it is desirable to increase slab lengths by this means.

INVESTIGATION OF CORRUGATED-METAL CULVERTS

The study of the erosion test for bituminous-coated corrugated-metal culvert pipe has been continued. The desirability of having a better abrasive for this test was mentioned in the last annual report. During the year experiments have been made with an abrasive charge made up of cubes of portland-cement mortar, fabricated and cured under careful control. The results thus far obtained indicate a marked improvement in the consistency of test results when the new abrasive is applied. A study of the effect of using various sands in making up the mortar cubes is being made.

FLEXIBLE-PAVEMENT DESIGN

The study of the general problem of the structural design of highway surfaces of the nonrigid type, such as gravel and macadam, has been continued and some progress has been made. A review of the reports resulting from researches, particularly those in foreign countries, has been completed. A study has been made of a dynamic method of testing developed and used in Germany, with particular reference to its possible use in this investigation. A report is being prepared that gives the status of present knowledge in this general field. The development of special apparatus for use in this investigation is being continued.

INVESTIGATION OF SUPPORTING STRENGTH OF FLEXIBLE CULVERT PIPE IN EARTH EMBANKMENTS

Pipe culverts of various types and materials are used extensively in highway construction. Until several years ago, the strengths of these culverts were specified arbitrarily without much reference to the load that they would have to carry in the embankment because methods of calculating this load were not known. As a result of cooperative study by the Bureau and the Engineering Experiment Station of Iowa State College, a method was developed for designing rigid culvert pipes, such as concrete and cast iron, that made it possible to design pipe so as to avoid breakage and expensive replacement.

Culvert pipe may be divided structurally into rigid and flexible types. The rigidity of the pipe has a controlling influence on its design. For a complete

solution of the problem, it is therefore necessary to devise methods of designing flexible pipes as well as rigid pipes.

The Bureau is now also engaged with that station in studying this phase of the problem. The behavior of pipes in actual fills is being studied in conjunction with laboratory and analytical studies for the purpose of producing a rational design procedure for flexible pipe.

INVESTIGATION OF BRIDGE FLOORS

Empirical rules are now used to a great extent in designing highway bridge floors because of the absence of accurate analyses of the problem. These rules are based upon meager experimental data and many questionable assumptions have to be made in applying them to the types of bridge floors generally used. The result is a serious lack of accurate knowledge of the behavior of bridge floors under traffic and much confusion among bridge engineers as to methods of design.

Several years ago the Bureau made a start in the rationalization of the design of bridge floors by mathematically analyzing the simplest case—that of a wide concrete slab on rigid supports subjected to truck-wheel loads. This has permitted more accurate design of floors of this type but the conditions in most bridge floors do not correspond closely to the ones assumed. To eliminate the present uncertainties in floor design, it is necessary to make theoretical analyses of the various types of floor in use and to verify these analyses by observing the performance under loads of actual floors of the same types.

Work of this character is being conducted cooperatively by the Bureau, the University of Illinois, and the Illinois Division of Highways. The cooperative work was started in 1936 and considerable progress has been made in mathematical analyses and preparing for the experimental part of the program.

The results of this investigation will have direct application to practically all modern highway bridges and will result in more accurately designed structures.

PORTLAND CEMENTS, AGGREGATES, AND CONCRETE

During the last few years it has become evident that chemicals such as calcium chloride and sodium chloride, when used for melting ice on concrete pavements, may cause severe scaling of the surface of the pavement. This has become a serious problem in certain of the Northern States where ice frequently forms on pavements and steps must be taken to prevent skidding. Experiments conducted in New York indicate that when a certain amount of portland cement is replaced by natural cement in making concrete, a surface considerably more resistant to this action is produced. During the year the Bureau has conducted a large number of laboratory tests to determine the effect of using this blended cement on the strength, elasticity, volume change, and other characteristics of concrete. Numerous tests on concrete containing portland cements of different chemical composition with and without a natural cement blend have been made to determine the comparative resistance to freezing and thawing in a solution of calcium chloride. These tests were made on samples of concrete taken from concrete roads constructed in New York during the last 3 years.

The results so far indicate that the resistance of the surface of the concrete to the action of calcium chloride and sodium chloride can be materially increased by the use of a blend consisting of about 85 percent of portland cement and 15 percent of natural cement by weight. They also indicate that, so far as may be determined from laboratory tests covering a period of 1 year, the strength and other properties of the concrete are not seriously affected by the use of the blend.

The Los Angeles abrasion test, to which reference was made last year, has been given further study, particularly to correlate results of the tests with service behavior.[1] The test is applicable to various types of aggregates, such as crushed stone, gravel, and blast-furnace slag; and a large number of determinations, covering a wide range in quality, have been made on each of these types. In this connection tests have been made to correlate the results of the Los Angeles abrasion test with an accelerated service test in the laboratory, in which the aggregate is subjected to the action of a roller in a manner similar to the action of a road roller in the field. The tests made indicate that the Los Angeles test measures the ability of an aggregate to resist crushing under a roller considerably better than do the tests that have previously been used for this purpose.

Work was continued during the year on an extensive series of tests to determine the relative efficiency of several methods of curing concrete. The various pro-

[1] The Los Angeles test is used to determine the suitability of rock, gravel, and slag for use in highway construction. A given weight of pieces of the material is placed in a metal drum, together with steel balls, and the drum revolved 500 times. The amount of material worn away from the pieces is an indication of quality.

cesses are evaluated on the basis of comparative strength and water retention of concrete specimens to which the curing agent has been applied. These tests are being conducted under controlled temperature and humidity conditions and include 22 different methods of curing. The work so far indicates the extreme importance of applying wet burlap or some similar material to the concrete immediately after placing, regardless of the curing agent used later.

A report giving the results of the Bureau's latest studies of high-frequency vibration in placing pavement concrete was published during the year. Tests indicate that present specifications for pavement concrete may be modified to utilize vibration to advantage either by adjusting the proportions to give a slump of about 1 inch with the same net water-cement ratio as used in standard construction, or by adjusting proportions to give the same cement content as is used in standard construction but with a slump of 1 inch instead of 2½ inches. The first alternate should result in a saving of approximately 10 percent in the amount of cement used without sacrificing quality. The second alternate should result in an increased strength of approximately 10 percent as compared with standard methods of construction.

BITUMINOUS ROAD MATERIALS

Research on bituminous materials and their uses in road construction has continued along the general lines followed in previous years. It has included the laboratory examination of bituminous road materials and aggregates, field studies of problems in bituminous construction, and cooperative work with the State highway departments and committees of technical organizations in the development of specifications and test methods.

Laboratory studies of the properties of asphalt cements, tars, emulsions, and other liquid asphaltic road materials, are being continued to provide additional information about their physical and chemical properties and to determine those properties that are indicative of quality and service in order that suitable requirements necessary for given conditions may be specified. Constant changes in refinery procedure, affecting as they do the character of the material produced, make continuation of this study necessary.

The cooperation with the Minnesota State Highway Department and the University of Minnesota in a laboratory study of the weathering properties of asphalt cements is being continued.

A field and laboratory investigation of sheet asphalt pavements is being conducted on two projects in the District of Columbia to determine the changes that occur in the asphalt during construction and upon aging in service.

To determine the present condition of asphalts in old pavements and to investigate the changes in various asphalts as they occur under known conditions, a cooperative study has been initiated in Ohio in cooperation with the State highway department. The first phase involves sampling pavements and recovering the bitumen from a number of pavements built since 1931. The second calls for construction of an experimental road in which asphalts from various sources will be used. The effect of exposure in service and of the various phases of construction procedure such as heating, mixing, and laying will be studied.

Laboratory studies of hot and cold bituminous mixtures are being continued to develop methods of testing that will produce uniform results and will be indicators of probable service behavior.

The absolute viscosity of all grades of bituminous materials is being determined as a step toward a more logical and rational classification of the consistency of these materials. The general adoption of absolute viscosity as a measure of consistency would make it unnecessary to follow the present unsatisfactory practice of using different arbitrary tests to measure the consistency of various kinds and grades of bituminous materials.

Several methods of extracting and recovering the bituminous binders from paving mixtures, designed to give residues unchanged by the recovery process, are being studied. The changes occurring in the original bituminous binders during the mixing process, construction, and service, may be successfully observed if these recovery processes are satisfactory. Apparatus with which both bituminous materials and bituminous mixes can be subjected to accelerated weathering is being installed.

A study of the affinity between bituminous materials and mineral aggregates is being made to determine the tendency of certain bituminous-coated aggregates to become uncoated in the presence of moisture.

A circular track, together with other laboratory equipment, is being utilized to investigate the stabilizing effect of various bituminous materials on base courses for bituminous surfaces.

The study of bituminous and nonbituminous joint-filling materials installed on a section of the Memorial Highway to Mount Vernon is being continued. Materials proving unsatisfactory in service are removed and new materials, untried but appearing to have promise, are being installed.

Cooperative experimental roads have been built in Alabama, North Carolina, and Tennessee, to study the use of cotton-fabric reinforcement in bituminous construction and a similar project is being planned in South Carolina. These experiments involve a soil survey of subgrade and base materials, observations of construction, and an accumulated record of maintenance costs and service behavior. On each project, sections identical in character except for the presence or absence of cotton fabric were constructed so that definite information can be obtained relative to the value and limitations of the fabric. Many sections of road have been built by a number of the States with cotton fabric furnished to them under the Department's cotton-diversion program. Reports of construction, maintenance required, and service behavior of all such sections, will be prepared by the States to be assembled later and presented in a symposium on the use of cotton fabric in bituminous construction.

SUBGRADE INVESTIGATIONS

A growing appreciation of the value of soil analyses to the designing engineer has caused a large increase in the number of soil samples tested in the Bureau's laboratory in connection with highway construction involving Federal funds. The number of State highway departments regularly using the soil tests advocated by the Bureau has increased and with it the demand for check samples, check tests, and instruction in the technique of soil testing. It is apparent that this service, combined with studies of routine test methods to ascertain the causes of discrepancies in test results obtained by different operators, will become increasingly important in the future. The Bureau will also continue its work in the development of specifications based on subgrade soil tests.

The first of a series of regularly scheduled courses of instruction in soil surveying, sampling, and testing, and in the practical utilization of the information obtained, was held during the year. Formerly these courses have been held as occasion arose and have been attended by representatives of foreign governments, Federal bureaus, State highway departments, universities, and commercial organizations. The increased demand for this instruction necessitated the establishment of scheduled courses for those interested in the study of soils for highway purposes.

Soil mechanics, as related to foundations for bridges and embankments and to the stability of large earth formations, has become more important with increasing knowledge of the subject. A report has been published during the year on the theory of soil consolidation and testing of foundation soils. This report presents as simply as possible the mathematical relationships for expressing stress distributions and, by means of examples, illustrates the practical application of compression-test data. Investigations now in progress with a shear test and a stabilometer for measuring lateral pressure in soils should furnish valuable information on shear slides, the design of safe slopes, and stability in general. A cooperative investigation with the Bureau of Yards and Docks, Navy Department, utilizing data from compression, shear, and stabilometer tests, was helpful in the design of the foundations for a drydock at Mare Island, Calif. Further work in cooperation with the Navy Department has been planned.

Laboratory investigations of the relation between moisture content and the density and stability of soils when compacted in a particular manner have been continued. These tests have a practical significance in the construction of highway embankments, and fills are now being built under specifications based on the method of control suggested by the Bureau. In order to investigate more fully the economic value of moisture control in fill construction, arrangements have been made for the construction of two experimental projects in each of which different methods of compaction will be used. Detailed records will be kept during construction and correlated with service behavior and maintenance cost. In addition, laboratory tests will be made on undisturbed samples of soil from locations where fill failures have occurred. The combined results of these investigations should furnish valuable information on the rational design of embankments.

Roadway drainage and its relation to subgrade stabilization and frost-heave prevention have received much attention in the past. The recent recognition of the existence in soil of water in both the film state and the free state, and the determination of the vastly different properties of water when in the different states have served to explain many observed phenomena of soil-water movement.

Tests have now been developed for measuring the capillary pressure exerted by soils at different temperatures, for measuring the amount of free or drainable water, and for measuring the rate of flow of water through soils to the drains.

Soil stabilization in general, and as applied to the low-cost roads in particular, is one of the most important problems occupying the attention of the Bureau's research staff. Two circular tracks, approximately 35 feet in circumference, have been in operation during the year as a part of the investigation of base-course materials for thin bituminous surface treatments. The track inside the laboratory has been used to determine the influence of grading and plasticity index on the action of sand-clays and sand-clay gravels when used as base courses. The track located outdoors has been used to investigate the value of water-retentive chemicals for maintaining base courses low in plasticity prior to surface treatment. The effect of the chemicals on the physical properties of the base-course materials has also been determined as well as their effect on the bituminous surfacing. Both tracks will be operated continuously during the next year in the study of base-course problems with special reference to chert gravels and quarry screenings and to insoluble binders such as bituminous materials and portland cement for the stabilization of fine-grained soils.

Experimental base courses have been constructed in Nebraska and Minnesota to determine the effect of base thickness as well as grading and plasticity index.

A light truck has been equipped as a field laboratory and is being used in a survey of low-cost stabilized roads. A large mileage of such roads in the east-central part of the United States has been surveyed and the laboratory and field data are being correlated. Field work is being continued to determine the efficiency of various chemicals in soil stabilization.

A study of the chemical properties of soils in cooperation with the State Highway Commission of Missouri and the Agricultural Experiment Station of the University of Missouri has been continued. A report has been published giving the results of tests performed on a series of homoionic soils. This report shows the marked effect of the kind of ion absorbed by the soil materials on the physical properties of different soils and furnishes fundamental data on the possibilities of chemical treatment. Progress has been made in the development of quantitative and microchemical methods of analyzing soil and ground water.

Cooperation with the State highway departments in the making of subgrade surveys, in the design of subgrade treatments and road surfaces, and in the establishment of subgrade-soil laboratories has continued as in past years.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - Price 10 cents

REPORT OF THE CHIEF OF THE SOIL CONSERVATION SERVICE, 1937

United States Department of Agriculture,
Soil Conservation Service,
Washington, D. C., October 14, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I present herewith the report of the Soil Conservation Service for the fiscal year ended June 30, 1937.

Sincerely yours,

H. H. Bennett, *Chief.*

CONTENTS

INTRODUCTION

Events of the year allied the individual farmer and the Soil Conservation Service in a new and more effective approach to the problem of conserving soil resources on a national scale.

In 18 States, legislative action authorizing the formation of soil conservation districts opened for the first time an avenue through which the combined force of individual and governmental initiative can be exerted to the fullest in extending the principles of soil conservation to all of the country's agricultural land. Hitherto, such an avenue has been lacking; there has been no adequate link between the individual land user seeking to conserve his private resource and agencies of Government engaged in the conservation of a resource vital to society and the Nation as a whole. Direct contact between the two has been limited to areas selected for cooperative watershed demonstrations of erosion-control technique; the governmental approach to the whole broad problem of soil-erosion control has been based, consequently, upon the principle of education by demonstration. Now, as a result of State legislation, the soil conservation district emerges as a mechanism through which land users of any community may join with the Soil Conservation Service and other governmental agencies in the formulation and execution of conservation plans. The opportunity for cooperative action by these two conservation forces—the land user and Government—thus is broadened out; for the first time it extends not merely into isolated demonstration areas, but to the whole of our farm and grazing lands.

24718—37——1

From the standpoint of national soil husbandry and better land use, the importance of this development cannot be minimized. It establishes in a relatively large number of States the foundation of principle and the framework of democratic procedure upon which a long-time, comprehensive program of soil conservation can be carried out across the vast bulk of our agricultural land.

The necessity for State legislation to accomplish this end was outlined by the President on February 27, 1937, in the following letter addressed to the Governors of the States:

MY DEAR GOVERNOR: The dust storms and floods of the last few years have underscored the importance of programs to control soil erosion. I need not emphasize to you the seriousness of the problem and the desirability of our taking effective action, as a Nation and in the several States, to conserve the soil as our basis asset. The Nation that destroys its soil destroys itself.

In the Act of Congress approved April 27, 1935 (Public No. 46 of the 74th Congress), the Federal Government, through the Soil Conservation Service of the Department of Agriculture, initiated a broad program for the control of soil erosion. Demonstration work has been undertaken but much remains to be done. The conduct of isolated demonstration projects cannot control erosion adequately. Such work can only point the way.

The problem is further complicated by the fact that the failure to control erosion on some lands, particularly if such eroding lands are situated strategically at the heads of valleys or watersheds, can cause a washing and blowing of soil onto other lands and make the control of erosion anywhere in the valley or watershed all the more difficult. We are confronted with the fact that, for the problem to be adequately dealt with, the erodible land in every watershed must be brought under some form of control.

To supplement the Federal programs, and safeguard their results, State legislation is needed. At the request of representatives from a number of States, and in cooperation with them, the Department of Agriculture has prepared a standard form of suitable State legislation for this purpose, generally referred to as the Standard State Soil Conservation Districts Law. The Act provides for the organization of "soil conservation districts" as governmental subdivisions of the State to carry on projects for erosion control, and to enact into law land-use regulations concerning soil erosion after such regulations have been approved in a referendum. Such legislation is imperative to enable farmers to take the necessary cooperative action.

I am sending to you several copies of the Standard State Soil Conservation Districts Law, with a memorandum summarizing its basic provisions. I hope that you will see fit to make the adoption of legislation along the lines of the Standard Act part of the agricultural program for your State.

Very sincerely yours,

FRANKLIN D. ROOSEVELT.

The 18 States which had enacted districts legislation by the end of the year were Arkansas, Indiana, North Dakota, South Dakota, Utah, New Mexico, North Carolina, Nevada, Georgia, Kansas, Oklahoma, South Carolina, Minnesota, Colorado, Nebraska, Maryland, New Jersey, and Florida. In most of the remaining 30 States similar legislation was at some stage of development or consideration when the year ended. While no soil conservation districts were formed during the year in those States which adopted enabling legislation, preliminary steps looking to the creation of districts had been started in several localities. Indications at the close of the year were that a number of districts will be formed during the fiscal year 1938.

The favorable trend of State action on districts legislation was accompanied by certain fundamental adjustments in the basic operating policies of the Service. Definite plans for shifting emphasis from the demonstration phase of Service activities to the wider field of active cooperation with soil conservation districts were being developed and perfected. Procedures to be followed in establishing and carrying on erosion-control work in cooperation with districts were being formulated as rapidly as possible, although details remain to be worked out as the districts program goes into actual operation.

Meanwhile, the current program of the Service moved steadily ahead. Various phases of activity were more closely coordinated, particularly in bringing the facilities of research to bear upon the solution of technical problems encountered in field operations. Relationships with other agencies, both State and Federal, were improved and advanced materially.

Demonstration operations were extended during the year to cover a total of 8½ million acres of private land. More than 50,000 individual landowners were cooperating with the Service in the treatment of this land. Ten new demonstration projects were established and ten old ones were transferred from an active to a maintenance status.

The retirement of critically eroding land from cultivation to the security of permanent protective cover, together with the increase in erosion-resisting crops, was a significant aspect of this demonstration work. Agreements with the Service now call for devoting approximately 26 percent of the cultivated land to uses considerably less conducive to erosion than those previously prevailing.

These uses are permanent hay, range and pasture, woodland, and crops of a soil-protecting character.

This 26 percent reduction in clean-tilled crops is significantly greater than the corresponding figure at the end of the fiscal year 1936, when agreements called for a 20-percent reduction. This increased reduction of clean-tilled crops indicates a wider application of complete conservation programs rather than reliance on one or several uncoordinated erosion-control measures. The retirement of more than one-fourth of the clean-tilled cropland on farms cooperating with the Service to such diversified uses as permanent meadows, pasture, woodland, and soil-protecting crops indicates that the program of the Service, as applied farm by farm, is actually bringing about a complete physical readjustment of land use.

COOPERATIVE RELATIONS AND PLANNING

The Division of Cooperative Relations and Planning maintained liaison for the Service both with other governmental agencies and with the public.

In cooperation with the Solicitor of the Department, it rendered active assistance to State officials in connection with State legislation patterned after the standard State soil conservation districts law; achieved noteworthy progress in the establishment of working agreements with a number of State extension services; and, in keeping with the growth of erosion-control activity, prepared and disseminated an increased amount of informational material to the public.

Long-time planning activities were concerned primarily with working out for the Service a basis of cooperation with local organizations operating to conserve soil resources under the provisions of State legislation. In order to determine what types of erosion-control activity appeared permissible under existing State laws, the Section of Cooperative Planning analyzed a number of statutes dealing with the conservation of natural resources or the zoning of agricultural lands. Upon request, advice was prepared for State officials on the adequacy of such legislation to achieve effective control of erosion and to meet the requirements for Federal assistance in local effort. The Section also reviewed procedural interpretations of this conservation legislation in the State courts with a view to assisting in the adaptation of the standard State soil conservation districts law to meet the constitutional and administrative requirements of particular States.

By the end of June, statutes on the general order of the standard State soil conservation districts law had been enacted by 18 State legislatures at the regular 1937 sessions. These laws were similar, in that each set up a State soil conservation committee and provided for the creation of local districts with certain specified types of powers. They differed so widely in their detailed provisions, however, that analysis of each was necessary to determine the advisability of the Department's cooperation in local soil conservation work. Such analysis was made of a number of statutes by the Section of Cooperative Planning in collaboration with the office of the Solicitor. The Section also prepared during the year suggested procedures to guide State soil conservation committees in the exercise of their responsibilities under soil conservation districts legislation.

Representatives of the Section cooperated with the Agricultural Adjustment Administration in analyzing basic data and developing criteria for classifying soil-depleting and soil-conserving crops and establishing rates for grants to farmers cooperating under the agricultural conservation program. In this connection, measures of erosion control recommended for each of the principal type-of-farming subregions by regional and State offices of the Service and by State agricultural colleges were summarized by the Section and presented to the Agricultural Adjustment Administration for consideration.

COOPERATIVE RELATIONS IN EXTENSION

Relationships in the field were maintained by the Section of Cooperative Relations in Extension, working largely through the established mechanism of the various State extension services and the State soil conservation advisory committees composed usually of the State director of extension, the director of the agricultural experiment station, and the State coordinator of the Soil Conservation Service. By the end of the year plans for the development of State soil conservation programs had been formulated by 26 State advisory committees with the assistance of the Section.

Relations with State extension services were clarified and improved by memoranda of understanding outlining the general basis for cooperation be-

tween the two agencies. During the year such memoranda, including renewals, were signed and approved in 42 States. In addition, plans of work specifying in some detail the joint responsibilities of the two agencies were drafted and approved in 33 States. Under these plans of work 73 extension soil conservationists were selected jointly to assist in executing the extension phases of the erosion-control program.

These employees, together with the county agents, were active in stimulating local interest in soil conservation. Educational meetings were held with farmers' organizations, service clubs, and schools. Information regarding the soil conservation program was distributed through extension publications. Tours of demonstration projects and work-camp areas were arranged and conducted under the guidance of Soil Conservation Service officials.

Outside of projects and camp areas, extension soil conservationists and county agents assisted the Service in the establishment of individual farm demonstrations to aid in the further spread of soil conservation principles and practices. Such farms, exemplifying a plan of operations similar to that employed on watershed demonstration areas, were established in a number of counties included within the general problem areas represented by the demonstration projects and camps.

Assistance was also rendered by the Section to voluntary local soil conservation associations in the development of programs and the formulation of policies. Owing to interest in soil conservation districts legislation, however, little attention was given to the formation of these associations, especially outside of project and camp areas. Nevertheless, approximately 100 such associations were in existence at the close of the year without the facilities of a nearby project or camp.

INFORMATION

As the research and demonstration programs of the Service progressed, information activities became of increasing importance. With each improvement in erosion-control technique, and each addition to the store of fundamental knowledge relating to the preservation of soil and water resources, the Service was called upon to discharge its responsibility for disseminating this useful information to the public.

This was done through working relationships with the press and with radio-broadcasting outlets, the preparation of bulletins, and the development and utilization of exhibits, motion pictures, and related mediums of visual information. The Section of Information engaged also in a variety of functions not strictly informational, but of over-all service to the organization, including the production and processing of photographs, the procurement of printing, binding, and duplicating services, and the procurement and distribution of certain publications.

Refinements in policy and procedure enabled the Service to present soil conservation information to the public at more timely intervals, and with more localized adaptation. This resulted in increased use of the information disseminated.

Small information staffs in each of the 11 regional offices completed their first year of activity. Working relationships with extension editors in most States were solidified and improved, and a useful flow of soil conservation material maintained through established outlets for agricultural information in each State. Field activities were supervised by the Section of Information in Washington.

PRESS AND RADIO

The establishment of regional information staffs enabled the Service to place emphasis upon localized information and to eliminate most generalized material. Information bearing on local conditions and having direct local application was of more practical value to individual landowners and operators.

Press releases prepared by the Service totaled approximately 10,000 for the year. Most of these were released directly to local newspapers by demonstration project and Civilian Conservation Corps camp offices. More than 1,300 radio programs, including talks, interviews, and dramatizations, were broadcast over single stations and networks.

In Washington, the Section of Information prepared four "Farm Flashes" on soil conservation each week for the radio syndicate service of the Department. Previously, soil-conservation flashes were prepared by the Radio Service from material supplied by the Section of Information.

Although a proposed semimonthly schedule of participation in the National Farm and Home Hour radio program was prepared at the beginning of the year, it was impossible to follow it with any degree of exactness. At irregular intervals, however, as the availability of time and the opportuneness of the information dictated, the Service took part in the program. In addition, the Service participated on a regular weekly schedule in the Western Farm and Home Hour.

Short articles for the Clip Sheet of the Department's Press Service were submitted regularly, and both the regional and Washington information staffs prepared feature articles and photographic presentations on various phases of the soil conservation program at the request of newspapers and periodicals. Such articles appeared frequently during the year in national and regional publications, both agricultural and general.

EDITORIAL

Fifteen printed publications were issued. These include two circulars, three farmers' bulletins, two miscellaneous publications, three technical bulletins, four unnumbered publications and one handbook. Three additional manuscripts were submitted to the Department for publication.

The publication program of the Service was characterized chiefly by the preparation and publication of scientific information of fundamental value to technical workers of the Service. The first published records of soil conservation experimentation on the experiment stations of the Service appeared both in print and mimeographed form. Thus, for the first time, a definite scientific record, validated by continuous experimentation over an appreciable period of time, was made available to soil conservation workers and the public.

In the popular field, Soil Defense in the Piedmont—the first of a series of 11 regional farmers' bulletins appeared. Also, in the popular category were Conservation Farming Practices and Flood Control, Emergency Wind Erosion Control, Conservation of Soil and Water in the Pacific Northwest, Our Soil, Topsoil Its Preservation, Ten Billion Little Dams, and Cover Crops for Soil Conservation, a farmers' bulletin which has had wide circulation.

Other printed publications issued were Circular No. 402, Blue Grama for Erosion Control and Range Reseeding in the Great Plains and a Method of Obtaining Seed in Large Quantities; Farmers' Bulletin No. 1760, The Use of Bluegrass Sod in the Control of Soil Erosion; Miscellaneous Publication No. 256, Early Erosion Control Practices in Virginia; Technical Bulletin No. 524, Silting of Reservoirs; Technical Bulletin No. 556, Soil Conservation Reconnaissance Survey of the Southern Great Plains Wind Erosion Area; and Technical Bulletin No. 558, Soil and Water Conservation Investigations at the Soil Conservation Experiment Station, Missouri Valley Loess Region, Clarinda, Iowa, Progress Report 1931–35; Handbook, Procedure for Making Soil Conservation Surveys.

Soil Conservation, the official organ of the Service, completed its first full year of publication. The 12 issues of volume II contained 153 signed articles by 110 different authors. Each month 4,425 copies were distributed free to staff members of the Department of Agriculture, to libraries and scientific organizations, and to cooperating agencies. More than 200 paid subscriptions were reported by the Superintendent of Documents. Special issues of the magazine during the year featured upstream engineering, contour furrowing, flood and drought measures, and research.

At various times Soil Conservation gave timely publication to important data that otherwise might not have been available for many months. The magazine also helped bridge the gaps between specialized fields, by presenting a wide variety of viewpoints of the soil conservation program. In this way it helped develop a broad, comprehensive understanding of the Service, its practices, policies, and objectives.

Articles originating in the magazine brought comments and correspondence from many parts of the world, were used in preparation of textbooks and lectures, and were reproduced in various periodicals.

VISUAL INFORMATION

As in press and radio activity, the visual information work was aimed toward greater stimulation of local interest in soil conservation through presentation of localized material. In moving from general to a specific viewpoint, the regional information staff necessarily assumed a large part of the responsibility for preparation of exhibits and other mediums of visual information.

More than 70 exhibits were displayed on approximately 400 different occasions and, according to field estimates, were viewed by approximately 12,000,000 persons. In cooperation with the Division of Exhibits of the Department, the Service also prepared an animated model of soil conservation measures on a small watershed, for display at the Upstream Engineering Conference held in Washington in September 1936. This exhibit was later moved to the New York Museum of Science and Industry, where it was shown for 7 months.

A short motion picture presenting the soil-erosion problems of the Southwest was completed by the regional staff in cooperation with the Division of Motion Pictures of the Department. Another picture, somewhat longer, depicting the erosion problems and conservation measures of the southern Great Plains wind-erosion area, was virtually finished.

At the close of the year 11 film strips presenting different phases of soil conservation work and the erosion problems in different regions of the country were available. Seven others were in the process of production. In addition, a number of film strips prepared in cooperation with the Personnel Management and Training Division were available for use in personnel-training work.

Lantern slides for illustrative accompaniment of addresses and educational lectures were prepared, and at the close of the year more than 500 were cataloged and available to Service personnel.

The Section of Information continued to administer photographic activities through the regional information offices and the Service photographic laboratory in Washington. The laboratory handled 161,943 separate pieces, including prints, enlargements, copy negatives, and lantern slides.

EDUCATIONAL RELATIONS

The stimulation of interest in soil conservation brought increased requests from educators for general and technical information adaptable to teaching purposes in urban and rural school systems. To meet these requests and help foster the incorporation of soil conservation subject matter into the curricula of interested institutions, a professional educator was added to the information staff to direct educational relations.

Information for educational use and as basis for future education work was furnished by the regional offices and through Washington to State departments of education, divisions of the National Education Association, county and city educational administrative groups, scientific organizations, publishers and authors, individual teachers and university and teachers' college faculties, clubs, and other organizations. Cooperation with educators also included demonstration teaching work in southwestern schools.

In cooperation with educational personnel of the C. C. C., an educational program for C. C. C. enrollees engaged in erosion-control work was begun.

SERVICES

In addition to activities strictly informational, the Section of Information prepared 556 requests for printing and binding work for all units of the Service, 475 requests for duplicating services, and 492 requests for special photographic work done in the main laboratory of the Department.

Approximately 14,000 requests for publications were filled, and in cooperation with the Office of Information of the Department, approximately 36,500 copies of departmental publications were distributed. Distribution of Service bulletins, special reports issued in cooperation with other Federal agencies, and miscellaneous releases amounted to approximately 72,500 copies.

Free subscriptions to 76 periodicals and periodical reports were procured for Service personnel, and mailing lists containing more than 1,700 addresses were maintained. Publications on soil conservation and related subjects issued by cooperating agencies and the agricultural experiment stations were reviewed and distributed to the Service staff.

OPERATIONS

Operations in the field were directed and supervised by the Division of Conservation Operations through eight closely coordinated technical sections.

An operations procedure was developed for those field projects which have been in existence for a period of approximately 2 years and are ready to proceed on a self-sustaining or maintenance basis. Proposed new project and work areas were inspected and recommendations made as to their approval or disapproval. The principles of operation for new demonstration projects and work areas, and particularly for soil conservation districts, were outlined and codified.

It is expected that more widespread adoption of erosion-control measures and practices which have proved effective in demonstration areas may be secured through soil conservation districts; however, additional demonstration projects are also deemed necessary to effectuate a sound national soil conservation program by providing a background of substantial experience and by training personnel to assist in the adoption of proven programs.

In order to provide more adequately for the administration of areas which have problems of a similar nature, and to develop planning on a watershed basis, the boundaries of one region were changed during the year. Changes in the boundaries of some projects were also made to provide more suitable work areas and to permit the best possible demonstration program for the area involved.

Watershed run-off studies were established on six project areas in cooperation with the Division of Research, and plans were made to establish similar studies eventually on a total of 20 projects. These studies are to be conducted on watersheds generally less than 100 acres in extent in order to collect rainfall and run-off data needed for the economic design of erosion-control and water-conservation devices. Work continued on the cooperative hydrological studies conducted by the United States Geological Survey on watersheds within nine of the demonstration areas operated by the Soil Conservation Service.

The project areas were used for collecting information on the effectiveness of various practices; and much of this information should prove valuable and adaptable on a national scale. The Division of Conservation Operations also cooperted with the Division of Research in establishing procedure for surveys which will definitely record data obtained by observation of erosion-control measures in operation on the various demonstration areas.

Improvements were made in the field organization of the Division and efforts were made to obtain a clear interpretation of the technical and administrative responsibilities of all sections. To effectuate a coordinated national program, as well as to provide assistance in local improvements, general field inspection from the Washington office was placed on a more efficient basis with designated staff members of all sections devoting more time to general examination of the various phases of the operations program in the field. As a result, improvements were made in field operations, both in the methods of carrying out different phases of the program on the land and in drawing up the plans of conservation operations which guide the erosion-control activities on the various farming areas included in the demonstration program. This new emphasis resulted in a lowered governmental expenditure for every unit of area treated and a higher degree of interest from cooperating farmers. Continued demonstration of practices and methods which farmers could adopt independently led to a more extensive application of such measures outside of project and camp areas.

Representatives of the Division served on various departmental and interdepartmental committees working on the problems of drought relief, flood control, agricultural conservation, and erosion-control surveys. The Division also furnished personnel to make cross-sectional examinations of the Ohio Valley flood plain, from Pittsburgh, Pa., to Cairo, Ill., thus making it possible to estimate the erosion and deposition damage caused by the disastrous flood of January 1937. Under emergency conditions, equipment and assistance were made available to local areas in distress owing to forest fires, drought, or flood and storm damage.

In the latter part of 1936 the flood control coordinating committee was established in the Department with the Soil Conservation Service representative as chairman. This committee was largely instrumental in outlining the procedure for interbureau and interdepartmental cooperation in flood-control work. It also named various field committees composed of field representatives of the Department to assume responsibility for the several watersheds included in the Omnibus Flood Control Act of June 1936. When funds are made available, it will be the responsibility of these field committees to make the investigations and the watershed reports, in keeping with provisions of this act.

PRIVATE LAND

At the close of the year, approximately 528 soil conservation demonstration and work areas, including those operated by the Civilian Conservation Corps camps, were active in 42 States. In these project and camp areas, approximately 8½ million acres of land in private ownership had been placed under 50,516 cooperative agreements with the Service. Of this total area, approximately 7 million acres were under treatment while on 4¼ million acres the

Soil Conservation Service had completed its share of the work, with the exception of the supervision required to assist cooperators in fulfilling their share of the agreements.

Of the 8½ million acres covered by cooperative agreements, approximately 2,416,000 were under cultivation at the time of signing contracts. The agreements call for converting approximately 634,000 acres of this cultivated land to other uses—namely, 258,000 acres to permanent hay, 157,000 acres to range and pasture land, 134,000 acres to woodland, and 85,000 acres to erosion-resisting crops and other similar uses. In other words, approximately 26 percent of the cultivated acreage in the demonstration areas is to be devoted to uses considerably less conducive to erosion than those which previously prevailed.

The major treatments provided to cropland under the cooperative agreements are the establishment of approved rotations on 3,269,000 acres, the contour tilling of 2,560,000 acres, the strip cropping of 1,372,000 acres, and the terracing of 1,631,000 acres. In addition, a total area of 496,000 acres is to be protected by cover crops between periods of regular crop production.

On pasture and range land under the agreements, erosion-control, and water-conservation work includes stock adjustments, improved grazing practices, fencing, stock-water development, and other practices. In addition, 649,000 acres are to be contour furrowed for moisture conservation. Vegetation will be reestablished on pasture and range land by means of applying fertilizers, and by seeding and sodding. Approximately 84,000 acres of pasture and range land on badly eroded slopes are to be converted to woodland and wildlife areas.

The work accomplished on woodland and wildlife areas under the agreements consisted of treatment of 55,000 acres as demonstration plots, the planting of 206,000 acres in the establishment of new woodland areas, fencing to exclude grazing, fire control, and other woodland and wildlife-management practices. Agreements call for placing a total of 1,216,000 acres of woodland under proper management for erosion control and for development as productive areas.

The status of the conservation operations carried out on private lands by the Service under cooperative agreement with the landowners is shown in table 1.

TABLE 1.—*Status of private-land program, cumulative, June 30, 1937*

Item	Activities of— Soil Conservation Service and Civilian Conservation Corps on project areas	Activities of— Civilian Conservation Corps outside project areas	Total
EXTENT OF PROJECTS			
Projects ... number	[1] 148	[2] 380	528
Do ... acres	8, 155, 517	[3] 9, 500, 000	17, 655, 517
Farms in projects ... number	57, 572	[4] 76, 000	133, 572
Area under cooperative agreements ... acres	3, 283, 302	5, 260, 147	8, 543, 449
Farms under cooperative agreements ... number	22, 236	28, 280	50, 516
Area under treatment ... acres	2, 382, 329	4, 513, 849	6, 896, 178
Area on which treatment has been finished [5] ... do	1, 704, 605	2, 536, 515	4, 241, 120
PROGRAM AGREED TO UNDER COOPERATIVE AGREEMENT			
Area to be in approved rotations ... acres	1, 226, 918	2, 042, 116	3, 269, 034
Area to be contour-tilled ... do	1, 029, 023	1, 530, 907	2, 559, 930
Area to be protected by cover crops ... do	155, 654	340, 018	495, 672
Area to be strip-cropped ... do	624, 940	747, 418	1, 372, 358
Area to be terraced ... do	659, 450	971, 102	1, 630, 552
Area to be taken out of cultivation ... do	263, 600	370, 314	633, 914
Area to be contour-furrowed ... do	260, 838	388, 599	649, 437
Pasture and range to be converted to woodland ... do	27, 478	56, 086	83, 564
Area to be under controlled grazing ... do	903, 416	2, 482, 235	3, 385, 651
Area to be dedicated to forest crops ... do	484, 788	731, 226	1, 216, 014

[1] In addition, 11 new projects were approved as of June 30, 1937, upon which operations have not been started.
[2] Camps doing all or more than 25 percent of their work off demonstration areas.
[3] Estimated 25,000 acres work area at each camp location.
[4] Estimated 200 farms in work area of each camp.
[5] Acreage on which the Government has completed its share of the work, with the exception of the supervision required to see that the cooperator fulfills his agreement.

TABLE 1.—*Status of private-land program, cumulative, June 30, 1937*—Continued

PRESENT STATUS OF PROGRAM

Item	Activities of—		Total
	Soil Conservation Service and Civilian Conservation Corps on project areas	Civilian Conservation Corps outside project areas	
Area in approved rotations ... acres	947, 916	1, 602, 712	2, 550, 628
Area contour-tilled ... do	780, 763	1, 069, 219	1, 849, 982
Area protected by cover crops ... do	128, 606	274, 840	403, 446
Area strip-cropped ... do	400, 422	452, 001	852, 423
Area terraced ... do	459, 836	509, 324	969, 160
Area taken out of cultivation ... do	242, 327	334, 695	577, 022
Area contour-furrowed ... do	171, 573	263, 176	434, 749
Pasture and range converted to woodland ... do	23, 270	48, 077	71, 347
Area under controlled grazing ... do	860, 563	2, 425, 312	3, 285, 875
Area in woodland and wildlife plantings (gully) ... do	23, 684	51, 961	75, 645
Area in woodland and wildlife plantings (all other) ... do	55, 802	74, 229	130, 031
Area dedicated to forest crops ... do	397, 805	542, 071	939, 876
Area developed especially for wildlife ... do	4, 257	16, 413	20, 670
Area in farms cooperating in wildlife management ... do	867, 022	1, 278, 656	2, 145, 678

OTHER FIELD OPERATIONS COMPLETED

Grassed waterways ... square yards	17, 403, 639	23, 196, 551	40, 600, 190
Permanent hay ... acres	64, 880	61, 912	126, 792
Trees, shrubs, and woody vines ... number	102, 126, 941	190, 864, 671	292, 991, 612
Crop-residue utilization [6] ... acres	16, 319	1, 479	17, 798
Diversions ... linear feet	3, 646, 450	8, 429, 321	12, 075, 771
Water-spreading structures ... do	852, 517	905, 484	1, 758, 001
Terrace-outlet structures ... number	176, 835	87, 398	264, 233
Gully-control structures:			
Permanent dams ... do	21, 595	23, 028	44, 623
Temporary dams ... do	564, 887	624, 881	1, 189, 768
Bank sloping ... square yards	14, 973, 175	40, 865, 936	55, 839, 111
Water-conservation dams ... number	670	2, 067	2, 737
Storage provided by water-conservation dams ... acre-feet	3, 357	59, 485	62, 842
Terraces ... miles	31, 072	37, 320	68, 392
Fences [7] ... rods	1, 087, 388	2, 502, 982	3, 590, 370

[6] Figures are for the fiscal year 1937 only.
[7] Figures are for the fiscal years 1936 and 1937 only.

In all erosion-control demonstration and camp areas the endeavor to bring about soil and water conservation is a cooperative effort undertaken by both the farmer and the Soil Conservation Service. At the beginning of the demonstration work it was necessary for the Service to carry a large share of the costs because the majority of farmers recognized neither the seriousness of the erosion problem nor the advantages to be derived from soil and water conservation. During the year, however, the program progressed to such an extent that the contributions of cooperating farmers have nearly balanced the total expenditures made by the Government.

The effectiveness of the demonstration areas is increasingly apparent through the spread of soil-conserving practices outside demonstration and camp areas. It is also worthy of notice that cooperating farmers are now furnishing practically all supplies and materials for installation of the erosion-control program on their farms. The contributions of the Service are generally limited to technical service for planning, labor (relief, C. C. C., etc.), and such heavy equipment as is not available on the cooperating farms at present.

Table 2 shows the present status of the private-land program as carried out on project areas and by camps.

TABLE 2.—*Private-land program by States and regions, fiscal year and cumulative totals,*[1] *June 30, 1937*

State and region	Areas	Gross area [2]	Area under cooperative agreements [3]		Farms under cooperative agreements [3]		Area under treatment [3]		Area on which treatment has been finished [3]		Area in cultivation before contract [3 4] (accumulative)	Area taken out of cultivation [3 4] (accumulative)
			Fiscal year	Accumulative	Fiscal year	Accumulative	Fiscal year	Accumulative	Fiscal year	Accumulative		
	Number	*Acres*	*Acres*	*Acres*	*Number*	*Number*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Region 1:												
Maine:												
Project areas	1	30,000	3,022	4,927	17	27	2,091	3,486	2,153	2,153	3,035	92
Civilian Conservation Corps camps	0											
Total		30,000	3,022	4,927	17	27	2,091	3,486	2,153	2,153	3,035	92
Maryland:												
Project areas	1	29,230	1,779	3,958	24	53	2,100	2,882	2,124	2,411	837	199
Civilian Conservation Corps camps	2	50,000	17,734	20,288	126	150	11,900	13,489	6,437	6,785	3,768	622
Total		79,230	19,513	24,246	150	203	14,000	16,371	8,561	9,196	4,605	821
New Jersey:												
Project areas	3	70,990	8,452	19,920	122	247	10,219	20,818	6,481	9,865	7,803	1,399
Civilian Conservation Corps camps	2	50,000	9,809	19,043	83	158	1,063	4,311	4,461	6,644	7,788	2,005
Total		120,990	18,261	38,963	205	405	11,282	25,129	10,942	16,509	15,591	3,404
New York:												
Project areas	3	205,230	21,948	60,693	177	462	21,366	36,470	18,022	27,906	7,310	720
Civilian Conservation Corps camps	6	150,000	56,743	68,557	368	553	37,442	44,701	22,811	27,632	5,699	505
Total		355,230	78,691	129,250	545	1,015	58,808	81,171	40,833	55,538	13,009	1,225
Pennsylvania:												
Project areas	4	217,966	22,337	55,763	250	562	11,368	28,624	6,737	21,006	6,952	2,329
Civilian Conservation Corps camps	7	175,000	48,479	64,677	417	557	21,865	29,131	14,794	19,554	10,213	5,540
Total		392,966	70,816	120,440	667	1,119	33,233	57,755	21,531	40,560	17,165	7,869
Vermont:												
Project areas	1	65,250	4,845	6,110	17	22	5,258	5,258	506	506	400	105
Civilian Conservation Corps camps	0											
Total		65,250	4,845	6,110	17	22	5,258	5,258	506	506	400	105

West Virginia:												
Project areas	2	180,750	7,373	74,988	85	572	5,812	54,321	5,914	54,213	3,030	1,677
Civilian Conservation Corps camps	7	175,000	39,451	80,584	198	450	47,728	61,910	19,441	24,699	6,715	1,287
Total		355,750	46,824	155,572	283	1,022	53,540	116,231	25,355	78,912	9,745	2,964
Total project areas	15	799,416	69,756	226,359	692	1,945	58,214	151,859	41,937	118,060	29,367	6,521
Total Civilian Conservation Corps camps	24	600,000	172,216	253,149	1,192	1,868	119,998	153,542	67,944	85,314	34,183	9,959
Total		1,399,416	241,972	479,508	1,884	3,813	178,212	305,401	109,881	203,374	63,550	16,480
Region 2:												
Alabama:												
Project areas	3	167,888	14,671	133,680	130	891	25,050	109,905	14,499	36,800	55,387	23,358
Civilian Conservation Corps camps	8	200,000	120,012	266,849	518	1,326	121,214	207,536	88,424	131,029	109,871	22,701
Total		367,888	134,683	400,529	648	2,217	146,264	317,441	102,923	167,829	165,258	46,059
Florida:												
Project areas	1	20,940	6,165	14,452	52	149	8,175	12,341	7,973	7,973	4,772	1,237
Civilian Conservation Corps camps	0											
Total		20,940	6,165	14,452	52	149	8,175	12,341	7,973	7,973	4,772	1,237
Georgia:												
Project areas	5	256,567	30,953	151,338	167	1,105	31,971	81,889	16,604	31,322	50,685	17,653
Civilian Conservation Corps camps	9	225,000	32,749	88,234	176	441	37,368	50,936	20,427	27,101	40,541	7,822
Total		481,567	63,702	239,572	343	1,546	69,339	132,825	37,031	58,423	91,226	25,475
Mississippi:												
Project areas	5	275,985	35,477	126,867	169	741	44,211	84,608	28,527	49,185	47,853	8,646
Civilian Conservation Corps camps	12	300,000	71,028	126,898	338	591	50,808	83,655	31,473	46,853	57,264	8,183
Total		575,985	106,505	253,765	507	1,332	95,019	168,263	60,000	96,038	105,117	16,829
North Carolina:												
Project areas	8	458,500	34,140	240,288	434	2,628	22,335	85,351	35,595	62,958	64,487	20,742
Civilian Conservation Corps camps	16	400,000	142,680	311,686	1,088	2,293	77,263	130,334	71,945	89,356	97,403	26,660
Total		858,500	176,820	551,974	1,522	4,921	99,598	215,685	107,540	152,314	161,890	47,402
South Carolina:												
Project areas	5	250,449	21,913	136,483	236	1,511	26,706	68,842	20,391	51,957	64,810	23,488
Civilian Conservation Corps camps	8	200,000	124,673	261,932	732	1,501	71,468	119,122	38,222	53,854	106,553	37,426
Total		450,449	146,586	398,415	968	3,012	98,174	187,964	58,613	105,811	171,363	60,914

[1] Figures for the project areas include C. C. C. work on demonstration areas. C. C. C. figures represent camps doing all or more than 25 percent of their work off demonstration areas.

[2] Gross area of projects authorized by Division of Conservation Operations and estimated work area of 25,000 acres for each camp.

[3] The deductions made in cumulative figures for agreements canceled account for any discrepancies between figures in this table and those in the annual report for 1936.

[4] Refers to clean-tilled crops only.

TABLE 2.—*Private-land program by States and regions, fiscal year and cumulative totals, June 30, 1937*—Continued

State and region	Areas	Gross area	Area under cooperative agreements		Farms under cooperative agreements		Area under treatment		Area on which treatment has been finished		Are in cultivation before contract (accumulative)	Area taken out of cultivation (accumulative)
			Fiscal year	Accumulative	Fiscal year	Accumulative	Fiscal year	Accumulative	Fiscal year	Accumulative		
Region 2—Continued.	*Number*	*Acres*	*Acres*	*Acres*	*Number*	*Number*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Virginia:												
Project areas	4	288,000	7,027	99,805	38	741	25,306	63,026	13,078	32,072	17,983	6,297
Civilian Conservation Corps camps	10	250,000	82,565	183,365	380	1,030	86,583	119,310	48,520	59,049	27,883	7,064
Total	------	538,000	89,592	283,170	418	1,771	111,889	182,336	61,598	91,121	45,866	13,361
Total project areas	31	1,718,329	150,346	902,913	1,226	7,766	183,754	505,962	136,667	272,267	305,977	101,421
Total Civilian Conservation Corps camps	63	1,575,000	573,707	1,238,964	3,232	7,182	444,704	710,893	299,011	407,242	439,515	109,856
Total	------	3,293,329	724,053	2,141,877	4,458	14,948	628,458	1,216,855	435,678	679,509	745,492	211,277
Region 3:												
Indiana:												
Project areas	2	55,680	7,831	12,806	73	120	5,463	9,811	3,201	7,549	2,333	818
Civilian Conservation Corps camps	10	250,000	46,771	119,118	298	810	46,519	85,604	45,305	73,704	22,834	6,837
Total	------	305,680	54,602	131,924	371	930	51,982	95,415	48,506	81,253	25,167	7,655
Kentucky:												
Project areas	3	80,000	12,683	28,404	177	313	14,429	18,332	11,604	13,637	6,782	4,001
Civilian Conservation Corps camps	14	350,000	64,840	161,519	380	996	59,750	107,957	61,786	96,590	29,286	7,657
Total	------	430,000	77,523	189,923	557	1,309	74,179	126,289	73,390	110,227	36,068	11,658
Michigan:												
Project areas	1	36,300	3,543	5,362	64	94	1,348	4,410	1,848	3,196	2,752	688
Civilian Conservation Corps camps	0	------	------	------	------	------	------	------	------	------	------	------
Total	------	36,300	3,543	5,362	64	94	1,348	4,410	1,848	3,196	2,752	688
Ohio:												
Project areas	4	177,416	19,001	75,062	160	644	11,108	65,155	6,230	63,546	10,080	1,831
Civilian Conservation Corps camps	18	450,000	76,813	200,970	502	1,373	78,151	172,687	64,286	151,808	35,456	10,165
Total	------	627,416	95,814	276,032	662	2,017	89,259	237,842	70,516	215,354	45,536	11,996

Tennessee:												
Project areas	1	25,000	250	1,871	20	20	0	0	0	0	948	948
Civilian Conservation Corps camps	6	150,000	21,784	38,374	121	208	11,055	16,216	15,043	20,885	14,358	4,950
Total		175,000	22,034	40,245	141	228	11,055	16,216	15,043	20,885	15,306	5,898
Total project areas	11	374,396	43,308	123,505	494	1,191	32,348	97,708	22,883	87,928	22,895	8,286
Total Civilian Conservation Corps camps	48	1,200,000	210,208	519,981	1,301	3,387	195,475	382,464	186,420	342,987	101,934	29,609
Total		1,574,396	253,516	643,486	1,795	4,578	227,823	480,172	209,303	430,915	124,829	37,895
Region 4:												
Arkansas:												
Project areas	6	284,800	40,557	126,266	349	964	59,126	100,222	44,169	70,307	39,097	8,308
Civilian Conservation Corps camps	14	350,000	118,626	235,391	697	1,523	92,304	137,355	66,690	93,830	83,502	23,629
Total		634,800	159,183	361,657	1,046	2,487	151,430	237,577	110,859	164,137	122,599	31,937
Louisiana:												
Project areas	6	206,100	46,304	114,160	291	766	37,729	88,327	43,729	69,665	54,025	11,257
Civilian Conservation Corps camps	14	350,000	133,099	198,782	594	1,003	107,321	137,761	62,930	77,167	77,764	8,699
Total		556,100	179,403	312,942	885	1,769	145,050	226,088	106,659	146,832	131,789	19,956
Texas:												
Project areas	8	476,000	39,278	183,256	291	1,328	52,357	150,705	62,425	118,647	97,726	18,130
Civilian Conservation Corps camps	25	625,000	151,802	353,123	799	2,044	138,001	252,304	114,487	167,405	173,331	28,894
Total		1,101,000	191,080	536,379	1,090	3,372	190,358	403,009	176,912	286,052	271,057	47,024
Total project areas	20	966,900	126,139	423,682	931	3,058	149,212	339,254	150,323	258,619	190,848	37,695
Total Civilian Conservation Corps camps	53	1,325,000	403,527	787,296	2,090	4,570	337,626	527,420	244,107	338,402	334,597	61,222
Total		2,291,900	529,666	1,210,978	3,021	7,628	486,838	866,674	394,430	597,021	525,445	98,917
Region 5.												
Illinois:												
Project areas	3	195,580	9,092	111,832	77	685	14,779	106,730	16,135	101,541	52,451	207
Civilian Conservation Corps camps	27	675,000	142,297	251,544	857	1,693	118,760	204,816	102,281	171,831	75,129	11,895
Total		870,580	151,389	363,383	934	2,378	133,539	311,546	118,416	273,372	127,580	12,102
Iowa:												
Project areas	5	184,000	18,978	131,603	136	856	18,544	92,009	33,222	62,068	54,416	10,120
Civilian Conservation Corps camps	20	500,000	80,888	253,382	492	1,654	76,233	187,944	65,317	155,222	74,519	9,797
Total		684,000	99,866	384,985	628	2,510	94,777	279,953	98,539	217,290	128,935	19,917

TABLE 2.—*Private-land program by States and regions, fiscal year and cumulative totals, June 30, 1937*—Continued

State and region	Areas	Gross area	Area under cooperative agreements		Farms under cooperative agreements		Area under treatment		Area on which treatment has been finished		Area in cultivation before contract (accumulative)	Area taken out of cultivation (accumulative)
			Fiscal year	Accumulative	Fiscal year	Accumulative	Fiscal year	Accumulative	Fiscal year	Accumulative		
Region 5—Continued.	*Number*	*Acres*	*Acres*	*Acres*	*Number*	*Number*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Minnesota:												
Project areas	4	211,300	7,240	43,883	53	337	9,947	36,327	9,332	34,107	7,352	788
Civilian Conservation Corps camps	12	300,000	44,427	98,815	278	577	38,063	79,743	40,666	67,960	13,111	668
Total	------	511,300	51,667	142,698	331	914	48,010	116,070	49,998	102,067	20,463	1,456
Missouri:												
Project areas	4	231,000	16,446	154,921	105	1,089	21,641	136,552	9,982	103,483	34,855	22,959
Civilian Conservation Corps camps	20	500,000	102,271	246,715	592	1,466	103,329	169,759	90,758	144,257	46,057	12,780
Total	------	731,000	118,717	401,636	697	2,555	124,970	306,311	100,740	247,740	80,912	35,739
Wisconsin:												
Project areas	3	496,140	49,217	58,031	459	511	5,686	50,898	5,685	49,473	5,319	768
Civilian Conservation Corps camps	16	400,000	42,036	129,924	241	725	42,897	98,059	56,365	79,807	15,031	1,680
Total	------	896,140	91,253	187,955	700	1,236	48,583	148,957	62,050	129,280	20,350	2,448
Total project areas	19	1,318,020	100,973	500,277	830	3,478	70,597	422,516	74,356	350,672	154,393	34,842
Total Civilian Conservation Corps camps	95	2,375,000	411,919	980,380	2,460	6,115	379,282	740,321	355,387	619,077	223,847	36,820
Total	------	3,693,020	512,892	1,480,657	3,290	9,593	449,879	1,162,837	429,743	969,749	378,240	71,662
Region 6:												
Colorado:												
Project areas	4	385,960	67,589	133,289	130	251	69,882	115,413	52,945	80,150	12,582	6,822
Civilian Conservation Corps camps	9	225,000	91,897	172,052	86	203	86,921	166,250	123,608	155,582	10,614	4,066
Total	------	610,960	159,486	305,341	216	454	156,803	281,663	176,553	235,732	23,196	10,888
Kansas: Project No. 4	1	58,000	10,428	24,548	24	66	13,897	22,149	8,619	10,746	32	32
New Mexico: Project No. 4	1	49,920	8,437	24,830	15	60	6,456	14,576	7,023	7,884	1,387	276
Oklahoma: Project No. 9	1	25,600	4,840	13,880	21	62	6,049	10,907	1,406	1,406	0	0

Texas:												
Project areas	5	226,560	12,122	119,131	23	212	33,638	96,995	35,170	55,007	1,029	[5] −448
Civilian Conservation Corps camps	5	125,000	155,043	408,260	191	542	158,547	380,150	61,027	96,234	68,966	9,005
Total	------	351,560	167,165	527,391	214	754	192,185	477,145	96,197	151,241	69,995	8,557
Total project areas	12	746,040	103,416	315,678	213	651	129,922	260,040	105,163	155,193	15,030	6,682
Total Civilian Conservation Corps camps	14	350,000	246,940	580,312	277	745	245,468	546,400	184,635	251,816	79,580	13,071
Total	------	1,096,040	350,356	895,990	490	1,396	375,390	806,440	289,798	407,009	94,610	19,753
Region 7:												
Kansas:												
Project areas	3	175,000	13,017	99,641	83	518	8,503	74,817	10,635	75,750	25,234	[5] −457
Civilian Conservation Corps camps	14	350,000	56,679	80,632	239	333	47,762	68,639	28,342	35,376	14,175	1,188
Total	------	525,000	69,696	180,273	322	851	56,265	143,456	38,977	111,126	39,409	731
Nebraska:												
Project areas	3	102,000	4,332	44,777	32	245	3,440	41,742	2,861	39,319	17,450	1,808
Civilian Conservation Corps camps	16	400,000	62,964	198,869	339	1,001	61,782	172,224	60,340	105,558	73,863	19,923
Total	------	502,000	67,296	243,646	371	1,246	65,222	213,966	63,201	144,877	91,313	21,731
Oklahoma:												
Project areas	9	459,500	50,372	213,141	398	1,608	41,891	161,948	34,997	123,246	74,142	23,267
Civilian Conservation Corps camps	21	525,000	100,455	334,345	751	2,191	102,991	244,992	88,946	172,317	119,066	40,354
Total	------	984,500	150,827	547,486	1,149	3,799	144,882	406,940	123,943	295,563	193,208	63,621
Total project areas	15	736,000	67,721	357,559	513	2,371	53,834	278,507	48,493	238,315	116,826	24,618
Total Civilian Conservation Corps camps	51	1,275,000	220,098	613,846	1,329	3,525	212,535	485,855	177,628	313,251	207,104	61,465
Total	------	2,011,500	287,819	971,405	1,842	5,896	266,369	764,362	226,121	551,566	323,930	86,083
Region 8:												
Utah:												
Project areas	2	200,000	34,140	66,482	71	147	4,534	16,594	4,534	16,594	0	0
Civilian Conservation Corps camps	4	100,000	0	78,678	0	36	0	16,622	0	16,622	356	0
Total	------	300,000	34,140	145,160	71	183	4,534	33,216	4,534	33,216	356	0
Total project areas	2	200,000	34,140	66,482	71	147	4,534	16,594	4,534	16,594	0	0
Total Civilian Conservation Corps camps	4	100,000	0	78,678	0	36	0	16,622	0	16,622	356	0
Total	------	300,000	34,140	145,160	71	183	4,534	33,216	4,534	33,216	356	0

[5] Increase in area under cultivation.

TABLE 2.—*Private-land program by States and regions, fiscal year and cumulative totals, June 30, 1937*—Continued

State and region	Areas	Gross area	Area under cooperative agreements		Farms under cooperative agreements		Area under treatment		Area on which treatment has been finished		Area in cultivation before contract (accumulative)	Area taken out of cultivation (accumulative)
			Fiscal year	Accumulative	Fiscal year	Accumulative	Fiscal year	Accumulative	Fiscal year	Accumulative		
Region 9:	*Number*	*Acres*	*Acres*	*Acres*	*Number*	*Number*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Montana:												
Project areas	2	64,000	11,964	37,024	38	107	28,546	35,767	18,665	19,134	1,247	[5] −457
Civilian Conservation Corps camps	1	25,000	1,692	2,122	4	5	78	78	42	42	913	743
Total	------	89,000	13,656	39,146	42	112	28,624	35,845	18,707	19,176	2,160	286
North Dakota:												
Project areas	2	91,640	15,598	28,287	63	110	14,804	26,957	6,468	11,899	3,621	1,015
Civilian Conservation Corps camps	1	25,000	5,915	6,407	45	56	6,079	6,079	6,079	6,079	827	211
Total	------	116,640	21,513	34,694	108	166	20,883	33,036	12,547	17,978	4,448	1,226
South Dakota:												
Project areas	2	229,280	14,288	82,784	59	328	13,793	79,549	16,807	53,319	18,430	7,805
Civilian Conservation Corps camps	4	100,000	14,602	24,248	62	117	12,924	20,007	5,508	12,948	7,833	2,521
Total	------	329,280	28,890	107,032	121	445	26,717	99,556	22,315	66,267	26,263	10,326
Wyoming:												
Project areas	2	333,356	29,626	30,878	66	74	4,569	5,686	4,569	5,686	1,438	976
Civilian Conservation Corps camps	0	------	------	------	------	------	------	------	------	------	------	------
Total	------	333,356	29,626	30,878	66	74	4,569	5,686	4,569	5,686	1,438	976
Total project areas	8	718,276	71,476	178,973	226	619	61,712	147,959	46,509	90,038	24,736	9,339
Total Civilian Conservation Corps camps	6	150,000	22,209	32,777	111	178	19,081	26,164	11,629	19,069	9,573	3,475
Total	------	868,276	93,685	211,750	337	797	80,793	174,123	58,138	109,107	34,309	12,814
Region 10:												
California:												
Project areas	7	192,640	12,742	44,608	173	449	16,846	45,563	15,228	31,268	32,244	5,339
Civilian Conservation Corps camps	6	150,000	4,066	13,303	72	174	8,229	10,070	7,837	9,193	8,323	162
Total	------	342,640	16,808	57,911	245	623	25,075	55,633	23,065	40,461	40,567	5,501

Nevada:												
Project areas	1	50,000	444	1,149	5	30	4,677	15,440	4,297	15,440	60	[5] −4
Civilian Conservation Corps camps	2	50,000	1,443	1,795	14	121	7,928	11,596	6,938	10,586	113	0
Total	------	100,000	1,887	2,944	19	151	12,605	27,036	11,235	26,026	173	[5] −4
Total project areas	8	242,640	13,186	45,757	178	479	21,523	61,003	19,525	46,708	32,304	5,335
Total Civilian Conservation Corps camps	8	200,000	5,509	15,098	86	295	16,157	21,666	14,775	19,779	8,436	162
Total	------	442,640	18,695	60,855	264	774	37,680	82,669	34,300	66,487	40,740	5,497
Region 11:												
Idaho:												
Project areas	1	25,000	14,044	18,855	45	64	16,223	16,411	14,268	14,456	1,249	614
Civilian Conservation Corps camps	2	50,000	29,162	43,264	125	161	35,354	45,424	17,085	20,379	9,623	3,849
Total	------	75,000	43,206	61,119	170	225	51,577	61,835	31,353	34,835	10,872	4,463
Oregon:												
Project areas	3	132,000	14,769	38,376	25	106	13,913	34,155	22,029	33,667	8,560	1,188
Civilian Conservation Corps camps	5	125,000	32,706	53,110	57	82	795,539	808,772	73,328	73,328	13,721	1,402
Total	------	257,000	47,475	91,486	82	188	809,452	842,927	95,357	106,995	22,281	2,590
Washington:												
Project areas	3	178,000	14,360	84,886	67	361	14,549	50,361	2,648	22,088	32,199	5,786
Civilian Conservation Corps camps	7	175,000	42,252	64,292	77	136	28,263	48,306	24,574	29,249	19,612	3,805
Total	------	353,000	56,612	149,178	144	497	42,812	98,667	27,222	51,337	51,811	9,591
Total project areas	7	335,000	43,173	142,117	137	531	44,685	100,927	38,945	70,211	42,008	7,588
Total Civilian Conservation Corps camps	14	350,000	104,120	159,666	259	379	859,156	902,502	114,987	122,956	42,956	9,056
Total	------	685,000	147,293	301,783	396	910	903,841	1,003,429	153,932	193,167	84,964	16,644
Grand total:												
Project areas	148	8,155,517	823,634	3,283,302	5,511	22,236	810,335	2,382,329	689,335	1,704,605	934,384	242,327
Civilian Conservation Corps camps	380	9,500,000	2,370,453	5,260,147	12,337	28,280	2,829,482	4,513,849	1,656,523	2,536,515	1,482,081	334,695
Total	528	17,655,517	3,194,087	8,543,449	17,848	50,516	3,639,817	6,896,178	2,345,858	4,241,120	2,416,465	577,022

[5] Increase in area under cultivation.

24718—37——3

PUBLIC LAND—WESTERN WATERSHED PROJECTS

In addition to the work program on private land in 42 States, the Service continued to direct extensive erosion-control and land-management programs on four watershed projects located in largest part on public lands in Western States. The projects are: (1) Navajo Indian Reservation in New Mexico and Arizona, (2) upper Gila River watershed, including the San Pedro tributary in New Mexico and Arizona, (3) Rio Grande watershed above Elephant Butte Reservoir in New Mexico, and (4) the entire Shoshone Indian Reservation in Wyoming. The total land area within these watershed projects is 43,883,713 acres. The major portion of this land is owned by the Federal Government. About 21 percent is in private ownership and 7 percent is owned by the States.

The operations program for these public land projects seeks the following objectives: (1) To reestablish range vegetation through a comprehensive program of range management which includes the reduction of livestock in accordance with information gained from range-capacity surveys, the construction of drift fences, and the development of stock-water sources to facilitate better distribution of grazing and more uniform use of the range; (2) to promote the growth of vegetation by flood irrigation accomplished by the construction of dams and dikes to intercept and distribute surface run-off previously running to waste and frequently gullying valuable grazing and farm lands; (3) to reduce sheet and gully erosion as much as possible by (*a*) mechanical methods, such as diversion dikes, range terraces, contour furrows, simple checks, and water spreaders, and (*b*) the planting of stabilizing vegetation in adaptable positions; and (4) to protect valuable farm lands along streams through mechanical measures designed to prevent undercutting by meandering currents and through the planting of suitable trees, shrubs, and grasses in critical places. Vegetated areas established above stock-water ponds for the prevention of filling with erosional debris have proved outstandingly effective as a practical desilting measure.

In cooperation with the Indian Service, material progress was achieved in the development of sound land-use programs for areas on Indian reservations. On public land in grazing districts, cooperative work was carried on with the Division of Grazing where interests of the two organizations required the coordination of conservation plans. Joint effort also produced a land-use program for two areas purchased by the Resettlement Administration within the Rio Grande watershed. In short, this type of cooperation was widespread and conservation plans were developed with a number of administrative agencies holding original jurisdiction over various areas of land.

Twenty-seven C. C. C. camps assisted in the program on public land projects. Although the work areas of seven camps were located outside the watersheds, their activities were essentially the same as those working within.

Stock and range management is a prerequisite to successful erosion-control operations on range lands. Livestock reductions ranging from 24 to 37 percent were made on areas under agreement. This stock adjustment and other range-management practices on the work areas resulted in greater production of meat and wool per unit of stock. Wool from sheep on well-managed ranges was sold at higher prices because of better quality. Lamb crops also ran higher than those on adjoining ranges in poor condition.

The use of relatively small demonstration units as guides for applying control measures to broader areas for soil and water retention, water spreading, and arroyo treatment produced remarkable results. The measures installed, with the use of Civilian Conservation Corps and Works Progress Administration labor, demonstrated their effectiveness. The reestablished growth of vegetation from water spreading was apparent wherever measures had opportunity to function.

Progress is being made with reseeding adaptable types of depleted range. In this work, as in most other phases of the western watershed program, new technique had to be developed by the Service.

The status of public land—western watershed projects is shown in table 3.

TABLE 3.—*Status of four public land-western watershed projects, cumulative, June 30, 1937*

Item		Activities of—		Total
		Soil Conservation Service on watershed projects	Civilian Conservation Corps on and off watershed projects	
Area in watershed projects:				
Federal	acres	31, 521, 713	982, 000	32, 503, 713
State	do	3, 216, 000	1, 744, 000	4, 960, 000
Private	do	9, 146, 000	874, 000	10, 020, 000
Total	do	43, 883, 713	[1] 3, 600, 000	47, 483, 713
Land under agreement:				
Federal	do	14, 817, 901	646, 149	15, 464, 050
State	do	44, 315	739, 171	783, 486
Private	do	560, 352	570, 257	1, 130, 609
Total	do	[2] 15, 422, 568	[3] 1, 955, 577	17, 378, 145
Cooperative agreements	number	274	273	547
Extensive treatment completed	acres	1, 695, 489	901, 160	2, 596, 649
Diversions	linear feet	1, 199, 941	672, 075	1, 872, 016
Water-spreading structures	do	929, 013	12, 640, 173	13, 569, 186
Gully-control structures:				
Temporary dams	number	375, 145	472, 019	847, 164
Permanent dams	do	68, 819	105, 028	173, 847
Contour furrows	acres	16, 898	7, 870	24, 768
Channel improvement by bank protection	linear feet	787, 440	5, 676, 107	6, 463, 547
Stock-water ponds	number	78	307	385
Fences	rods	228, 480	249, 280	477, 760
Water-conservation dams	number	53	312	365
Storage provided by water-conservation dams	acre-feet	239	1, 275	1, 514

[1] Approximate acreage of work area of 7 C. C. C. camps off watershed projects.
[2] This includes 13,829,666 acres in the Navajo project, which is under a memorandum of understanding with the Bureau of Indian Affairs.
[3] This includes 1,639,700 acres under agreement off watershed areas.

C. C. C. OPERATIONS

Demonstrations of erosion control and water conservation were conducted in 38 States by the Emergency Conservation Work camps assigned to the Service. An average of 440 camps, each with an average enrollment of 158 men, operated throughout the fiscal year.

Table 4 gives the Soil Conservation Service's quota of camps, personnel, and enrollees by quarters for the fiscal year 1937.

TABLE 4.—*Camps, personnel, and enrollees supervised by the Soil Conservation Service, fiscal year 1937*

Date	Camps operated	Personnel	Enrollees [1]	Date	Camps operated	Personnel	Enrollees [1]
	Number	*Number*	*Number*		*Number*	*Number*	*Number*
July 1, 1936	454	4, 583	72, 279	Apr. 1, 1937	425	4, 195	63, 868
Oct. 1, 1936	450	4, 261	67, 249	June 30, 1937	425	4, 180	72, 000
Jan. 1, 1937	450	4, 362	73, 487	Average	440		69, 776

[1] Average number enrollees per camp, 158.

Work of the E. C. W. camps in each of the 11 Soil Conservation Service regions conformed to the general policies of the Service. Each camp was attached to the nearest watershed project for the purpose of technical supervision, although approximately 90 percent of the camps worked on areas apart from project watershed areas.

The Service initiated a program of conservation education and job training for enrollees in camps under its supervision.

Through the agency of the C. C. C. camps, a well-rounded program of soil and water conservation was applied during the year to all types of land on thousands of farms and ranches located throughout the country. Cropland was cultivated on the contour, planted with alternating strips of clean-tilled and close-growing crops, or terraced where soil and slope warranted; crops were systematically rotated under the direction of expert agronomists. Land unfit for further crop production was retired from cultivation and converted to other uses.

Pastures were cleared of rocks and brush, treated with lime and fertilizer, and seeded to clover and pasture grasses; woodlands were thinned, cleared of dead and diseased trees, and fenced to keep out cattle. Range and pasture lands were contour furrowed to conserve moisture, while grazing was limited to prevent depletion of cover. Gullying was halted by vegetative and mechanical means.

C. C. C. EMERGENCY WORK

In addition to the work in erosion control, the C. C. C. camps assigned to the Service were active in the relief of emergency conditions arising from national disasters. The outstanding work of this kind during the year was carried out in connection with the Ohio and Mississippi Valley floods of January and February 1937 by the camps in or near the localities affected. Because of ready mobility and experience with handling difficult outdoor problems expeditiously, the erosion C. C. C. camps were thrown almost immediately into the rescue and evacuating work. In the Ohio Valley, where conditions were most critical, 41 out of 48 Soil Conservation Service camps cooperated with the Red Cross, National Guard, Army engineers, and local relief groups in evacuating refugees, removing household effects, distributing food, clothing, and medical supplies; and later in rehabilitating dwellings, clearing silt and debris from highways, and reestablishing communication lines.

Camps in other areas were equally active. In the Southeast all 15 of the Mississippi camps cooperated in flood-prevention and relief work in threatened districts. Five camps in the Arkansas danger zone bore the brunt of evacuation until outside help arrived, and one was turned into a hospital. Twenty-five thousand meals were served to refugees by camp cooks. In Illinois 24 camps participated in emergency flood relief, particularly in and around Mound City and Cairo, where a C. C. C. camp superintendent was in charge of building up the levee with sandbags. In many instances, enrollees and trucks from camps in States not directly affected were rushed to stricken areas.

DROUGHT RELIEF

The Service participated in the governmental drought-relief program, concentrating its activities chiefly in the most seriously affected areas in the Great Plains States and in some regions outside the Plains, both east and west of the Mississippi River. Approximately 2,900 drought-relief projects benefiting an area of more than 1,430,000 acres, were established with funds made available for the purpose by the W. P. A. An average of 10,002 men earned a total pay roll of $1,578,737 in this relief program.

Supervision, labor, tools, materials, and technical guidance were provided by the Service in developing soil- and moisture-conservation practices on drought-stricken farms. In all sections of the United States designated for drought relief the Service programs were planned to meet the peculiar requirements of individual counties, and included the construction of dams, development of springs, surveying of contour lines, laying out of terraces, contour strip cropping, contour furrowing, gully control, approved rotations, establishment of erosion-resisting crops, conversion of cultivated lands to permanent grasslands, terracing, lime grinding, planting of winter cover crops, and the cleaning of streams and drifted fence rows.

In the western area, where whole States were designated for emergency drought relief, the situation called for the development of a water-conservation program of considerable magnitude. This included the construction of dams supplemented with dikes for water-spreading purposes and of many reservoirs to provide water for livestock. Wherever possible, these dams were placed in strategic locations so that they might serve the dual purpose of stock supply and flood irrigation. Reservoirs for stock watering were also located along trails, where it is expected they will prove of great benefit when cattle are driven to shipping points. Some dams were built for the purpose of benefiting groups of stockmen, while still other smaller structures were erected

on areas controlled by grazing associations. These reservoirs were suitably located to provide uniform grazing. In one region alone, approximately 410 drought dams were constructed. Larger dams served in a few instances as main sources of water supply for towns and urban areas.

CONSERVATION SURVEYS

The conservation survey, or physical land inventory, provides the basis for all soil-conservation recommendations and plans made by the Service. By mapping present erosion conditions, slope, land use, and type of soil, Service technicians are able to acquire information which, considered in relation to economic factors, serves as a guide for the development of specific erosion-control plans. For more general plans involving large watersheds or other areas, reconnaissance surveys must be used until more complete information can be obtained through detailed studies.

Inspectors from the Section of Conservation Surveys visited every region for the purpose of correlating conservation survey mapping. A conference of regional heads of conservation surveys was held at Washington in November 1936. Regional conferences of conservation surveyors held in February and in March were also attended by Washington representatives of the Section.

Conservation-survey field work was completed on 109 private-land projects by the close of the year. Detailed mapping was nearly finished on the remaining 39 old projects, and was well under way on 11 new projects established since July 1, 1936. Detailed surveys on private-land demonstration projects during the year covered a total of 1,991,645 acres. In addition, 2,922,367 acres were surveyed, mostly by plane-table methods, on 380 E. C. W. areas. On public lands general reconnaissance surveys were made, covering 22,304,926 acres, and somewhat more intensive reconnaissance surveys over 12,839,210 acres. Detailed surveys were completed on 482,072 acres in demonstration projects and 30,121 acres in E. C. W. camp areas. A reconnaissance survey of the Gila project, covering 4,989,838 acres, was completed by the close of the year.

The program of conservation surveys outside demonstration projects also progressed. Field work was completed on 3 reconnaissance surveys, covering a total of 8,551 square miles, in Idaho, New Mexico, and North Dakota; and on 10 detailed surveys covering 2,180 square miles, located in 8 States. At the close of the year work was under way on 4 reconnaissance surveys, with 9,668 square miles completed; and on 16 detailed surveys, where the area covered was 4,216 square miles. Work was going forward in 28 States with a field-survey staff better trained and more adequately equipped than in the previous year.

Aerial photographs were used as base maps for all detailed surveys completed; and additional photographs were on hand or obtainable from other Government agencies for nearly all surveys contemplated in the future. This method of mapping permits more rapid and satisfactory work than would be possible with the use of plane-table base maps.

Reconnaissance surveys of 3,927 square miles and detailed surveys of 1,224 square miles, all in scattered farms in 34 States, were made in cooperation with the Agricultural Adjustment Administration. Data from these surveys were tabulated in regional and project offices and turned over to representatives of the latter agency.

An examination of the flood damage and siltation on farm lands in the entire Ohio River flood plain was made following the disastrous flood of January 1937. By making detailed examinations of 175 cross sections of the flood plain from Pittsburgh, Pa., to Cairo, Ill., each approximately three-fourths of a mile in width, it was possible to estimate the effects of the flood on rural lands. Over the total flooded area of 1,576,135 acres, which includes only the lower parts of the tributary valleys, it was estimated that total deposits of soil were more than 51,000,000 tons, while total removals within the flood plain were in excess of 13,000,000 tons. Damage to farm lands was greatest near bends in the river channel, where bars and banks of unproductive sand were deposited.

Erosion-survey data obtained from planimeter measurements, showing interrelations of the four factors mapped, were tabulated and summarized by the report unit. Besides completing tabulations of 7 projects in progress at the beginning of the year, the unit analyzed the results of 10 surveys and made the data available to regional officials and others concerned. Similar tabulations were started for 15 additional projects. One report, of the reconnaissance survey of 20 counties in the southern Great Plains completed in 1936, was published as Technical Bulletin 556, together with a map of each county and a generalized

erosion map for the area. Seven manuscripts of reports were reviewed and criticized in preparation for publication.

AERIAL SURVEYS

Aerial photographs were utilized by several branches of the service, especially in the operation of demonstration projects, in conservation surveys, and in research. Photographs of areas where work is to be done are procured in three ways: (1) By contract, where a satisfactory aerial survey has not been previously made by a Federal agency or commercial concern; (2) by reproduction from available existing aerial-survey negatives; or (3) by purchase when satisfactory existing negatives are not available to the Government.

Specifications were prepared and contracts awarded for approximately 58,107 square miles of aerial and photogrammetric surveys, of which 464 square miles were for private-land demonstration projects, 26,823 square miles for conservation surveys, and 30,820 square miles for Federal land projects or Indian reservations. The contracts for this latter work were awarded in cooperation with the Bureau of Indian Affairs.

In the previous fiscal year contracts were awarded for 246,499 square miles of aerial and photogrammetric surveys, of which 139,812 square miles were completed, inspected, and accepted during the fiscal year 1937. These consisted of 61,843 square miles of photogrammetric surveys which required the delivery of radial-controlled mosaic atlas sheets and celluloid radial-control sheets of sufficient accuracy to compile planimetric maps; 187 square miles of photogrammetric surveys which required the delivery of topographic maps; and 77,782 square miles of aerial photographic surveys.

An agreement was negotiated with the Puerto Rico Reconstruction Administration whereby inspection of the photogrammetric survey of Puerto Rico is to be performed by the Soil Conservation Service. Flying was completed on this survey and the mosaic work was nearing completion by June 30, 1937.

An aerial photographic laboratory was installed, in which additional photographs could be made from negatives delivered under contract, as well as from those loaned by other Government agencies. This laboratory was also equipped to compile and copy mosaics and to perform various other types of work in connection with aerial surveys. The equipment included two enlarging cameras, three contact printers, and one large copy camera.

A filing system was installed to show current information on prints and negatives indicating delivery, acceptance, or rejection: name of providing agency; scale; date of flying; and location of negatives. Such a system insures a quick reference and a complete record of prints and negatives at all times.

PHOTOGRAMMETRY

In mapping by photogrammetric methods from aerial photographs, a certain amount of ground control must be established at identifiable points on the end photographs of flight lines and at intervals throughout the area being mapped. From four to six ground-control parties were engaged in this type of work the entire year. A cooperative project with the United States Geological Survey and the American Society of Photogrammetry was initiated to determine the distance radial control can be accurately and economically extended from a fixed point. This project is being conducted in connection with the mapping of the National Agricultural Research Center at Beltsville, Md.

Ground control was completed and permanent marks were established on 36 demonstration projects and 11 conservation-survey areas, comprising a total of 7,372 square miles. These surveys were conducted in 24 different States. In executing this control work, 2,636 lineal miles of third-order traverse were extended; 638 permanent marks were set at 3-mile intervals along the traverse lines; and 1,773 photo-control points were stereoscopically identified on the photographs and their geographic positions determined. Planning of ground-control surveys was completed on 52 projects.

Geodetic and plane coordinate computations were completed on 50 projects, and map projections on transverse Mercator, Lambert, and polyconic projections were constructed for 52 areas.

Second-order horizontal control and third-order vertical control were extended throughout the experimental area of the Section of Watershed and Hydrologic Surveys, located near Waco, Tex. Data from the hydrographic survey in the lower Granite Gorge of the Colorado River were compiled, and reproductions were made therefrom showing the hydrography and topography of Lake Mead and vicinity.

Planimetric maps at a scale of 4 inches to 1 mile were completed on 30 projects, comprising an area of 2,213 square miles located in 18 States. Work equivalent to 2,697 square miles was completed on 16 additional projects.

The stereoscopic delineation of drainage on aerial photographs to be used by field conservation surveyors was completed on 4,281 square miles.

CARTOGRAPHIC DRAFTING

The draftsmen of the Service handled 1,444 separate jobs, ranging from simple drawings to large orders requiring several months for completion. In connection with conservation surveys, complete planimeter measurements were made on 27 sets of maps, including 7,534 square miles of detailed surveys, 8,305 square miles of reconnaissance surveys, and special siltation surveys of 640 square miles in the Ohio River flood plain; 3 detailed maps of demonstration projects were drafted and are now ready for publication; and 146 county base maps were prepared for use in reconnaissance surveys. The planimeter group also measured 26 reservoir surveys and cross sections.

The mapping group drafted 38 reservoir maps, 564 watershed maps, 670 E. C. W. camp area maps, 620 State or regional maps, and 438 project aerial survey contract, and other miscellaneous maps. In addition, 50 atlases showing activities of the Service were prepared, and 34 map stencils made.

The map library was expanded by the addition of 20,000 maps, making a total of approximately 200,000 now available for reference and use. In addition, archives copies of all aerial photographs received by the Service were filed. An index of approximately 21,000 decisions of the Board of Geographic Names was set up. More than 8,500 requests for maps were filled, requiring the shipment of 175,000 individual pieces of drafting.

General drafting work included 305 engineering, mechanical, and architectural drawings; 710 charts, forms, and graphs; 150 cover designs and sketches; 212 lantern slides and drawings; 117 posters, show cards, and signs; and 693 title layouts or captions. Hand coloring was done on 2,664 maps, illustrations, and charts and on 791 lantern slides, transparencies, and photographs.

Reproductions of 114,159 square feet of blue line prints and 35,196 square feet of photostat were made.

COORDINATION OF PRACTICES

Marked progress was made by the Section of Erosion Control Practices, in coordinating soil conservation measures into complete, practical, and economically sound erosion-control plans for individual farms and in incorporating these plans into cooperative agreements with farmers.

Effective July 1, 1936, the cooperative agreement form was revised to include a plan of conservation operations, which sets forth specifically the type of work to be accomplished on each field of the farm or ranch, indicates whether the work is to be carried out by the cooperator or by the Service, and in many cases includes brief provisions specifying how it is to be done. The provisions for changes in land use or farming practices are stated in narrative form in the plan of conservation operations rather than by symbols on the land-use map, as was formerly the practice. Thus, in addition to being more specific, the plans are more readily intelligible.

Special emphasis was laid on the development of complete soil- and moisture-conservation plans on all farms placed under cooperative agreement; and every effort was made to include all practices or methods necessary to this end. In the course of field inspections representatives of the section gave particular attention to the institution of an effective coordinated program for each farm under agreement, based on complete and economically sound farm planning.

At the beginning of the year some regions were handicapped by a lack of personnel in the Section of Erosion Control Practices. During the year, additional personnel were employed in some regions and the Section was more definitely organized in others. Additional conservationists were also added to many project staffs and their duties were more clearly defined. These changes helped materially in improving the quality of individual farm plans.

COOPERATIVE AGREEMENT REVIEW

Staff members from various regions were detailed to the Washington office to assist in reviewing cooperative agreements to determine their completeness and their conformity with national plans and policies. Where apparent weak-

nesses or deviations from national policies were found, this information was transmitted to the field and questions raised as to the justification for such deviations.

In similar fashion several regions detailed project personnel to the regional office to assist in checking cooperative agreements in that office previous to their transmittal to Washington. This practice brought about a marked improvement in the agreements from those particular regions.

By the close of the year plans were under way for the improvement and development of the review work through the organization of a cooperative agreement review unit in the Washington office. The personnel in this unit will assume responsibility for reviewing all cooperative agreements and farm plans submitted to the Washington office, and will cooperate with the field staff in further strengthening agreements already signed and approved.

FARM MANAGEMENT

A farm-management unit was organized in the Washington office in September 1936 for the purpose of reviewing cooperative agreements for economic soundness and feasibility. Prior to the organization of this unit, a number of projects in various regions had conducted farm-management surveys and had supervised the maintenance of farm accounts to obtain economic information which could be used as a basis for farm planning. In many cases, however, this material was not fully used as the data were not interpreted in a form convenient for farm planning. It is the function of the farm-management unit to cooperate with the field staff in assembling applicable farm-management data and to interpret these in usable form.

The unit's activities will include (1) collection and interpretation of farm-management information needed in developing a plan of work for an entire project area; (2) collection and interpretation of information needed to fit this area plan of work to the economic needs of the individual farm; and (3) gathering data to show what further changes are needed in the organization or management of farms already planned.

Notable progress was made in providing for the collection of these three types of information. On nearly every project initiated, farm-management surveys were conducted to provide a basis for area plans of work. In most regions information was also gathered to fit this plan to the indiivdual farms. And on many projects already established farm-account records were maintained or repeat surveys conducted to supply the data required for further development or revision of soil-conserving plans.

By the close of the year six regions had staff employees with training or experience in farm management who could give special attention to this phase of the work. Other regions were planning to add similar personnel to their staffs. It was also planned, especially on newly established areas, to include on each project staff an employee who could give special attention to the farm-management aspect of erosion-control planning.

AGRONOMY AND RANGE MANAGEMENT

The conservation of soil and water on approximately 62 percent of the land surface of the United States is dependent primarily on agronomic, pasture, and range-management practices. Pasture and range management are also involved in the protection of 12 percent of the area of the country, consisting of forest and woodlands used for grazing.

The protection and improvement of cropland alone is a most important phase of soil conservation work. In 1935 the farm value of the 78 principal crops amounted to 74 percent of the total gross income from farm production. In planning and carrying out agronomic practices for erosion control on cultivated lands, however, it is generally important also to take into account livestock requirements and management problems, since the feed supplied by harvested crops has a necessary bearing on the care and use of grazing land.

CROPLAND MANAGEMENT

Soil conservation work in the Cotton Belt has been marked during the year by improvements in crop rotations, more extensive use of strip cropping, a decided shift toward vegetative protection for waterways, increased interest in pasture improvement, the development of special types of treatment for special conditions, such as critical slopes and tobacco land, and a wider use of perennial legumes.

There has been a very definite shift during the year from masonry and concrete to vegetation for protecting terrace-outlet channels. The use of a limited amount of concrete still seems wise in strategic places where the slope or concentration of water is such that ordinary vegetation will not suffice. In the Texas blackland the multiple sodded channel is the outgrowth of a need for a very definite control of the velocity of water moving over comparatively steep ground on highly erodible soil, and at the same time for the safe removal of a large volume of water collected behind terraces of maximum length. If the volume of run-off water is unusually large, two or more sodded channels, wide and deep enough to control velocity without the need for costly permanent structures, are required. Rather than place channels at opposite ends of the terrace and thus at each side of a field, the channels are placed parallel to each other in the center. The terraces empty from both sides into the channels. This sodded area, under one fence, becomes an additional pasture, maintenance is a unit effort, and water is conducted to a safe grade under control, and over vegetation instead of over expensive structures.

Rotations have been improved by the use of a larger proportion of legumes and other close-growing crops. The most extensive use of small grains and sod crops has been in areas where there is the greatest need for food and pasture for livestock. The areas where most difficulty has been encountered in getting adequate acreages of close-growing crops established have been those in which the cash income is derived principally from row crops, such as cotton and tobacco.

Considerable advance has been made in the adaptation of strip crops to conditions existing on the farm. On critical areas, permanent strips of perennial legumes or annual legumes that reseed naturally and grasses are being established for the protection of the areas involved, as well as the land lying immediately below these strips. Special treatment of tobacco land has been an interesting development during the year. This treatment consists of the use of narrow sod strips with shallow diversion channels constructed below them. Tobacco rows have been run parallel to these strips, with the result that contour cultivation is effected.

The use of Hubam clover in the blackland of Texas for strip-cropping purposes is significant because it matures and can be turned under before the season for attack by cotton root rot. The development of permanent meadow buffer strips, using such perennial grasses as little bluestem, offers a great possibility for strip cropping long slopes without the use of terraces. Alfalfa, in parts of the western Cotton Belt, has been found successful as a strip crop. As an excellent hay crop, it has tended to make the practice of strip cropping more attractive.

The acreage devoted to perennial legumes has been substantially increased through the use of alfalfa, *Lespedeza sericea*, and kudzu. Whereas formerly *L. sericea* has been used principally in gully plantings and wildlife patches, during the past year it has been used much more extensively. As an example, in Alabama approximately 35,000 pounds of *L. sericea* seed were planted in permanent strips on critical slopes within cultivated fields.

There has been a tremendous increase in the use of kudzu during the past planting season. The vegetative cover which this plant produces, combined with its possibilities as a hay crop, has stimulated interest in its use, particularly in areas where older plantings are developing satisfactorily. It has a distinct advantage over other types of vegetation in that the vines spread from the more fertile portion of an area to the bare, galled portions. On projects where kudzu was planted in 1935, under reasonably good conditions, and was given first-year cultivation, some fields provide excellent cuttings of hay toward the end of the 1937 growing season.

Development of special treatment for critical areas, together with expanded use of mulching gullies and galled spots, has done much to reclaim many almost completely ruined areas as well as provide protection for adjacent land. Frequently the slope in the critical area will be twice the average slope in the field. Such critical areas are being retired from cultivation and strips of perennial vegetation, such as *Lespedeza sericea*, kudzu, and similar crops, established on them. This not only controls erosion on these areas but also protects portions of the fields above and below the critical areas.

An outstanding accomplishment in the Corn Belt has been the much more general acceptance of contour strip cropping. The results of experiment station work and the experience of farmers are proving valuable as a basis for improving methods for and stimulating interest in soil-saving practices and in increasing crop yields. Since livestock and livestock products provide a large portion of

the farm income in the Corn Belt, much attention has been given to cultural practices which will increase the quantity and improve the quality of the feed, forage, and pasture resources on each farm.

As a means of providing a better balance between the feed and forage supply on the farm and the animal units carried thereon, it was advisable in many instances to make use of supplemental pastures. This supplemental pasture has been secured by the use of annual grasses, such as Sudan grass or millet, the aftermath of new meadows, and alfalfa-grass meadows from which one cutting of hay had been taken earlier in the season. Winter annuals, such as rye or wheat, and other cover crops, have provided some early spring grazing prior to the time that permanent and rotation pastures could be utilized.

CROP ROTATIONS

Where short or indefinite rotations have been followed in the past, every effort was made to make these rotations longer and less irregular in order to reduce the frequency of plowing. The longer rotations are installed on the premise that legumes must be included to maintain and improve the productivity of the soil. In many cases grass-legume mixtures are included to provide sufficient hay and pasture for the livestock and to reduce the amounts of soil and water losses on sloping cropland. Changes in the cropping plans necessarily include the use of only those crops of known adaptation which have proved their worth from an economic standpoint and their value in preventing and retarding soil and water losses. A general reduction in the acreage of cultivated crops such as corn, soybeans, and tobacco, has been made on sloping croplands.

Interest continues to increase in the new concept of crop rotation by the contour stripping method as contrasted with the haphazard planting of fields having no planned adjustment to contour.

CONTOUR FURROWS

In the central Great Plains, it has not been possible to satisfy the demand for technical supervision in the construction of contour furrows, owing in part to the benefit payments for this practice made to farmers by the A. A. A. Farmers are using many kinds of implements, such as listers, moldboard plows, and disk plows. While the practice has gained its greatest impetus in short-grass country areas, it is now being used to speed the recovery of tall grasses in the Flint Hills of Kansas and other localities. In the northern Great Plains, the acreage on the farms of cooperators has increased from 100 to 5,000 during the year.

BASIN LISTING

In California, it has been demonstrated that basin listing is a highly satisfactory and relatively inexpensive erosion-control and moisture-conserving practice on slopes up to 15 percent, depending upon permeability of the soil. It is more effective when combined with deep cultivation, cover cropping, and other soil-improving practices. It has controlled erosion so successfully where properly used that a number of farmers have adopted it enthusiastically. In fact, it has been difficult to restrain them from using it on steep slopes and unsuitable soils. Results to date indicate that basin listing will become a very widespread practice. The results from this water-conservation measure have been very promising on areas of adaptable topography in various parts of the Great Plains. One of the main problems is to educate growers to limit its use to proper soil and slope conditions, and another is to fit the practice properly to the contour.

ANNUAL DITCHES

An annual ditch or terrace ridge is an erosion-control measure developed in the Pacific coast region for use where orchards are square-planted on sloping land. The terrace grade is laid out as near to a true grade as possible, following irregular lines through the square-planted orchard. Paint marks are made on the trunks of the trees so that the operator can follow the line of the terrace ridge without difficulty, and the markings are permanent. The terrace ditch or ridge is constructed in the fall before the winter rains and maintained until danger of winter rains is over. During spring cultivation the ditch or terrace ridge is usually obliterated by cultivation and is entirely removed during the summer months. Annual ditches can be constructed with ordinary farm implements such as a disk ridger or moldboard plow.

Maintenance of the ditches throughout the rainy season is very important. Failure of some cooperators to maintain them, with consequent heavy soil losses, has emphasized the importance of these annual ditches in erosion control in orchards. Only these very failures, due to negligence, could have served to demonstrate so forcibly the importance of these ditches as used in combination with terracing and cover cropping. The use of annual ditches is being gradually adopted by farmers.

Contour planting of orchards appears to be gaining headway as a result of demonstrations by the Service in New Jersey, Pennsylvania, and other States.

In the Northeastern States the use of cover crops and mulching are giving highly satisfactory results in the conservation of orchard land. Mulching is used principally on critical areas where cover crops are inadequate.

As the result of retiring to pasture land that is too steep for cultivation and of fertilizing pasture land in order to obtain sufficient cover to protect it, the making of grass silage may become an important practice. The silo is used for storing the excess spring growth before it matures and while its dry matter is more like a concentrate than a roughage on account of its high digestibility and low fiber content. With the storage of such feed, there is less occasion for overgrazing during less favorable parts of the year. When grassland can be used to produce the equivalent of concentrates, there is less occasion to use it for cultivated crops with the attendant risks of erosion.

RANGE MANAGEMENT

Most range land in the United States is found in areas where forage production is limited by low rainfall, and 10 to 100 or more acres are required to carry 1 head of mature cattle, or its equivalent in other animal units, for 12 months. About one-half of the western range, which comprises over one-third of the land area of the United States, is owned by private individuals and railroads. The other half consists of national forests and parks, Indian reservations, public domain, and State lands. This intricate pattern of ownership causes difficulty in establishing economic units for livestock production when making plans for erosion control.

Proper range management involves four factors: (1) Proper numbers, (2) proper class of stock, (3) proper seasonal use, (4) proper distribution. Proper stocking of the range in terms of numbers is of major importance. Unless proper stocking can be secured, any attempt to correct for the other factors is almost futile. In soil- and water-conservation work on land where erosion has been accelerated on account of excessive use by domestic animals, the usual objective of range management is an increased and improved vegetative cover on the land. This is to a large extent synonymous with improved quantity and quality of forage for livestock and hence can be most readily measured on an extensive scale by improvements in livestock production.

The Navajo Reservation is a notable example of the need for reducing numbers of livestock to the proper carrying capacity of the range. According to the dipping records, there have been rather gradual decreases since 1931 from 976,669 to 740,301 in the number of sheep and from 393,885 to 122,847 in the number of goats. The decrease in goats is particularly significant since the sheep and goats are herded together. This practice causes an excessive disturbance of the sheep where forage is scarce on account of their efforts to keep up with the goats and results in much damage to the range on account of unnecessary trampling. While there has been a considerable reduction also in the numbers of cattle and horses, no definite data are available. In spite of all these reductions, a reconnaissance in the spring of 1937 showed 80 percent of the Navajo range is still overgrazed. The results obtained on the Ganado demonstration area of 7,953 acres within the Navajo Reservation during the 1935–36 grazing year is an excellent example of the results of proper stocking.

This demonstration area was stocked in accordance with its estimated carrying capacity as determined by a range survey. It indicates that 200 ewes on a properly grazed range will produce more wool and as many lambs as 300 ewes on an overgrazed range. These lambs weigh nearly 50 percent more on the properly grazed range and sell for considerably more per pound, because they are in better condition and grade higher.

In the Rio Grande district, on 727,664 acres brought under range control, a reduction was made during the year in stocking from 12,325 to 7,787 animal units, or 37 percent. On the Gila district during the same time, a reduction of 5,638 animal units, or 24 percent, was accomplished. Such reductions on overgrazed range land, where there are no practicable means of lessening the pressure on the range by supplying additional feed, are definitely profitable to the operators,

since properly stocked ranges actually produce more feed than those that are overstocked. More feed for the proper number of stock kept on a production rather than a maintenance basis, means more meat and wool. The greater amount of forage being grown and held in reserve on the land keeps the productive topsoil in place, retains more of the rainfall in the soil, and reduces the silt load of streams used for irrigation.

ENGINEERING

Mechanical measures for erosion control form a necessary and important part of any coordinated plan of soil and moisture conservation. Material progress was made in coordinating the application of such measures with the use of vegetative controls, and in reducing the cost of mechanical land-treatment work, including terraces and diversion ditches for cropland, dams and contour furrows on pasture lands, dams and diversion dikes for range lands, and check dams in woodlands or other areas dedicated to permanent vegetation.

TECHNICAL INFORMATION

A conference was sponsored for the purpose of discussing erosion in orchards and preparing recommendations for control. A handbook on the design and construction of soil-saving dams and a bulletin on terracing were prepared for distribution. A study of bench terracing in the Southeast was made in an effort to obtain and correlate additional data pertaining to the application of mechanical measures of erosion control.

EQUIPMENT DEVELOPMENT

Efforts were made to adapt cultural and construction equipment to the problems encountered by the Service in its erosion-control activities. Studies were initiated and attempts made to promote the maximum use of existing equipment in carrying out recommended practices. The more serious equipment problems, however, were presented to the manufacturers of farm equipment in order that they might design and make available equipment adapted to conservation farming. Work was carried on in cooperation with these manufacturers and with the field personnel of the Service in developing special-purpose equipment, such as a grass-seed harvester in Texas, and in conducting field inspection of new-type terracers.

RECORDS AND STATISTICS

A new system of field reporting was installed under supervision of the Section of Engineering. A combined schedule was prepared to enable field offices to submit accomplishment, cost, and other data in a single periodic report. The availability of this information during the year enabled field supervisors to improve greatly the effectiveness of work operations. Work progress and technical cost records were maintained on the basis of these reports.

EQUIPMENT SPECIFICATIONS

Approximately 600 specifications to be used in bid advertisements for the procurement of major equipment were prepared during the year. Changes in equipment offered by manufacturers make it necessary that the Service be constantly abreast of new developments in the field of farm machinery in order to revise specifications from time to time.

The Engineering Section analyzed all bids from a technical standpoint to determine compliance with Service requirements on details of construction. Recommendations for award of contracts were made for all purchases of transportation and construction equipment by the Service during the year.

HIGHWAY EROSION-CONTROL DEMONSTRATIONS

In 8 of the 11 regions memoranda of understanding have been drafted between various State highway departments and the Soil Conservation Service to provide for joint participation in a program of erosion control along highways. In cases where such work is planned on Federal-aid highways, the Bureau of Public Roads is also a party to the agreement. To date the work has been largely of a fact-finding or demonstrational nature, confined to short stretches of highway near regular erosion-control projects where particular problems are

involved. The program is aimed at the control of erosion along highways by proper surface drainage and by the establishment of necessary vegetation on cuts and fills. In most instances the highway cross section is revised, making it necessary to consider traffic and safety requirements in evolving plans for erosion control. Ditches that provide adequate cross-sectional capacities and noneroding velocities were designed and constructed. Structures were eliminated wherever possible and banks sloped to permit the establishment of adaptable vegetation. In carrying out the construction phases of the highway program during the year 37,814 square yards of banks were sloped; 4,020 lineal feet of ditch were reshaped; 53,798 square yards of banks were seeded; and 146,923 square yards planted.

ADVANCES IN ENGINEERING TECHNIQUE

The most significant development during the year has been the decided trend toward the use of vegetation for the protection of terrace outlets, waterways, and other points of concentration that heretofore were thought to require the use of structural protection. This resulted largely from the efforts of the engineers in developing more efficient channel designs and the more complete knowledge they have gained of the ultimate velocity that is permissible in channels protected by various types of vegetation under differing conditions.

Multiple or parallel channel outlets, which constitute a new use of vegetation, have been developed in the South. Through the use of this type of outlet, drainages from much larger areas can be protected by vegetation.

The advantages derived from the use of vegetation in water channels have been increased materially because of the development of more efficient methods of establishment. A mechanical method of sprig sodding of Bermuda has been devised in the South. After the sod has been pulverized it is scattered by a manure spreader and later disked in and rolled—at a very material saving over the old method of hand placement. In the Ohio Valley there has been put into use a method of establishing seedings whereby the seedbed in the outlet is prepared, seeded, and fertilized, then mulched with straw, cornstalks, or other waste and the mulch tied down with wire. The mulch serves the double purpose of protecting the seed, by holding moisture, and of preventing cutting in the channel until the sod becomes established.

In the Northeast considerable use was made of diversion ditches, in conjunction with strip cropping, to protect critical field areas, as well as gully heads. This has been made possible because of greater knowledge of the possibilities of dispersion of water from the ends of these diversions and improvements in the methods of attaining it.

In the far West a temporary or annual terrace has been introduced to supplement vegetation in the control of erosion in orchards. This terrace is constructed in the fall before the winter rains set in and, if properly maintained throughout the winter, is very beneficial. In the Central West a new type of contour-furrowing machine has been developed that does not destroy any of the existing sod but produces an effective barrier, approximately 8 inches high, against the flow of water.

The value to the Service of the increased proportion of vegetative protection in the Southeast is indicated by the fact that only about 10 percent of the Service's expenditures for field work in that region are now made for gully control whereas formerly this expenditure was more than 50 percent. The increased use of vegetation in the Southeast is largely responsible for this saving. The Service has also developed high-velocity channels where mechanical protection is necessary. These are small, paved channels in which as high velocities as possible are produced. This admits of making the channel very much smaller and shorter than would otherwise be possible.

There has been a very decided advance in the design of terraces resulting from more complete understanding of what is necessary from the standpoint of farm operations as well as hydraulic design. Terraces are made the proper size to accommodate the farm machinery that is to be used. In the semiarid regions there has been a great improvement in the construction of stock ponds and small water-storage reservoirs. This has been brought about by more efficient construction methods and the effective use of overflow waters through the development of outlets designed to spread the excess water over areas that will benefit from the additional moisture.

The field men of the Service are becoming more proficient in the use of construction equipment and, consequently, are building all types of structures much more economically. More care has been given to the selection of construction equipment adapted to the various jobs being done, and more adaptable types

of equipment have been selected. The procedure for the execution of the various types of work being done has become more and more standardized. This is bringing about further economies.

WOODLAND MANAGEMENT

Widespread development of farm woodlands as a measure of soil conservation involves the introduction of a new attitude toward wooded areas. The former attitude that woods and waste land are synonymous is reflected in the condition of most farm woodlands.

Woodland-management demonstrations of the Service were designed to show methods of converting waste land to productive farm woods. They included planting trees on worn-out fields and eroded slopes, fencing woods to prevent erosion and other damage from grazing animals, taking steps for fire prevention, cutting timber selectively to bring about the best silvicultural conditions, and in general inducing the farmer to appreciate his woodland so that it will have an opportunity to become a producing unit of the farm.

Progress during the year was represented by more definite clarifications in policy and the drafting of a manual of field instructions. Important policies were established covering the extent of Service participation in planting tree and shrub windbreaks on farms in the Great Plains.

Under the soil conservation program, the most severely eroded cropland areas are removed from cultivation and converted to tree and shrub cover either by planting or by protecting the converted areas until natural establishment of suitable cover results. The cumulative effect of these changes up to and including December 31, 1936, was to increase the acreage devoted to woodland by 8 to 10 percent on farms constituting only 0.8 percent of the total farm acreage of the United States. A national plan of erosion control, when consummated, should increase the acreage of all farm woodland by at least 17 million acres, thus bringing the total from the latest census figure of 185 million acres to well over 200 million. This is believed to be a minimum figure; it seems more probable that the farm woodland area will eventually reach a total of between 225 and 250 million acres.

During the year 104,452,000 trees and shrubs were planted on farms under cooperative agreement. This amount, added to those previously reported, makes a total of 280,594,000 planted under the erosion-control program on 88,268 acres of farm land. Principles of woodland management were demonstrated by 5,279 cooperating farmers on 24,414 acres of land.

WILDLIFE MANAGEMENT

The restoration of vegetative cover is important both for control of erosion and conservation of wildlife. The removal of the original plant cover over large sections of the United States has permitted tremendous acceleration of erosion; loss of habitat has caused equally great reductions in animal populations. Logically, since the same cause has resulted in the depletion of the two resources, the conservation of both should be accomplished by the same means. With the proper direction, soil conservation means wildlife conservation.

Wildlife-management activities of the Service were divided into three phases: (1) Direct erosion-control planting made for the benefit of wildlife; (2) development of other soil conservation practices so as to enhance their value to wildlife; and (3) development of an appreciation on the part of the farmer, other conservation agencies, and the general public of the direct relationship between wildlife welfare and soil conservation.

During the year 3,882 acres of land in demonstration areas were planted in trees and shrubs and an additional 5,318 acres seeded to herbaceous vegetation beneficial to wildlife.

Under the Service's program 83,975 acres of land were planted to trees and protected by fencing, providing a haven for wildlife. In addition, shrub borders or interplanting and underplanting has made the woodlands of still greater value for animal populations.

Strip cropping was completed on 462,270 acres of cropland, all of which were made more useful than formerly for wildlife, since the increased amount of "edge", or technically, the better interspersion of plant life, is of value for game birds and mammals. The additional planting of odd corners which occasionally resulted from contour stripping, and the protection of eroding field borders by herbaceous or shrubby wildlife food plants, are two ways in which this farm practice was modified for wildlife benefit.

Pasture and range land placed under agreement amounted to 1,880,572 acres. Slight modification of grazing practices, such as changing spring dates of cattle release, permitted nesting birds to bring off broods on many acres of such land.

It is the policy of the Service to protect, for the benefit of wildlife, various pools, reservoirs, farm ponds, or stock-watering places by insuring that the shallower portions, at least, are fenced. Where feasible, reservoirs constructed by the Service for water-conservation purposes are built with a pipe leading through the dam to a watering trough placed below, thus permitting the protection by fences of the entire body of water. To prevent erosive wave action, to catch incoming silt, and to provide wildlife habitats, aquatic vegetation is planted or permitted to develop undisturbed on pond shores. During the year 2,091 such ponds were built, fenced, and protected for wildlife.

Land retired to permanent hay amounted to 68,990 acres. Minor changes in cutting dates and the use of flushing bars were modifications urged by the Service to enable this land to support nesting birds.

Rodent control necessary for the protection of structures on cooperators' farms in certain areas was carried on in close cooperation with the Bureau of Biological Survey. The total area treated amounted to 291,463 acres, a reduction over the figure for the fiscal year 1936 made possible in part through the development of rodent-resisting structures and the adoption of practices less encouraging to rodent depredation.

Under authority of the Director of Emergency Conservation Work, C. C. C. camps assigned to the Service erected 10,813 feeding stations in areas where winters make wildlife survival difficult.

Cooperation with State conservation agencies became increasingly close. It has always been the policy of the Service to relate soil conservation-wildlife work to that of State agencies. During 1936 an informal memorandum of understanding was developed between the Service and the State of Iowa, and similar ones were planned for other States. In North Carolina the continuation of wildlife work initiated by the Service was assured by interested State agencies. Upon request, soil conservation biologists taught 2 weeks of a 3-credit course in erosion-control practices at Louisiana Polytechnic Institute, Ruston, La. In New Mexico, Texas, and California liberation of game birds by the States on certain lands made habitable for wildlife by the Service was assured. In the State of Washington planting of beaver by the State on upland streams in erosion-control project areas resulted in the construction of 30 large beaver dams and numerous smaller ones. In many States the biologists of the Service were asked to assist in various ways in 4–H club work.

In the southern Piedmont region many active gullies in second-growth woodland areas and elsewhere, which were contributing relatively unproductive material to lowlands, have been stabilized with "gully mixtures" producing cover and food for wildlife. Most of these plantings have been visited by bobwhite or taken up as their more or less permanent abodes, and it is reported that such cover is giving good protection to the birds, as well as to rabbits, during periods of snow.

The development of better and less costly methods in erosion-control wildlife management is now beginning to show in increased efficiency of operation. Use of better seed mixtures for gully reclamation, application of principles of plant succession making possible less costly vegetative control, and the study of snow accumulation permitting more intelligent planting helped reduce the difficulties encountered in the work of the Service.

CONSERVATION NURSERIES

Significant progress was made in the operation of erosin-control nurseries for the propagation, collection, and storage of planting materials for use in soil- and moisture-conservation operations.

The general objectives of the Service influenced the nursery program, giving it a direction differing in some respects from the general concept of nursery activities. Soil conservation nursery functions include not only tree stock production but such additional activities as the quantity collection of seed of native grasses, trees, and shrubs for direct planting on demonstration projects; the assembly and observation in the nurseries of all types of plants, both native and exotic, which have superior merit for use in controlling erosion; seed-germination and purity tests; the production of grass and other forage-crop seed and sod; and the technical supervision of seed procurement.

A total of 55 stock- and grass-seed production and observational nurseries, covering 4,859 acres, was operated by the Section of Conservation Nurseries

during the year. A number of small nurseries were discontinued in the interest of economy and efficiency and stock production concentrated in larger nurseries so located as best to meet the specific needs of the Service. On June 30, 1937, the Service was operating 43 nurseries, and long-time plans anticipate a further reduction to approximately 35 by the end of the next fiscal year. Production sufficient to meet the planting requirements of the Service will be maintained by concentration in larger nurseries.

Major accomplishments of the year include the furnishing of 139,414,850 plants and 9,450,821 pounds of seed for use in demonstration projects and camp areas. Of these totals, 113,581,150 plants were produced in the Service nurseries, 14,617,900 seedlings were secured under cooperative agreements with Federal and State agencies, and 11,215,800 plants were purchased from commercial and State nurseries. In addition to this nursery stock which includes only materials actually delivered for use in the erosion-control program, 59,090,185 plants were grown and carried over in the nurseries for future use. The work as a whole involved the propagation, growing, and distribution of 134 genera and 325 species of plants including trees, shrubs, forbs, vines, and grasses.

Of the seed stock furnished, both for use in the nurseries and for direct project planting, 1,499,767 pounds of native tree and shrub seed and 221,612 pounds of native grass seed were collected. The remainder, consisting of 7,434,654 pounds of field seed and 56,795 pounds of tree and shrub seed, was obtained largely from commercial sources on competitive bids, the Nursery Section arranging the transactions and supplying technical supervision for the purchases.

Table 5 itemizes the stock-production operations of the nurseries, including in the regional production figures 1,897,000 plants obtained from the United States Forest Service and 12,620,900 plants secured from State nurseries through cooperative arrangements.

TABLE 5.—*Summary of nursery stock produced and purchased, 1937*

Region	Usuable plants produced				Plants carried over			
	Conifers	Hardwoods	Shrubs	Total	Conifers	Hardwoods	Shrubs	Total
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
1	180	14,228,982	1,112,397	15,341,559	30,524,550	0	150,000	30,674,550
2	38,627,430	14,977,145	3,424,670	57,029,245	500,000	0	0	500,000
3	157,300	15,362,800	685,000	16,205,100	2,584,000	25,000	0	2,609,000
4	3,508,100	4,305,415	205,500	8,019,015	1,636,800	1,172,155	73,845	2,882,800
5	1,505,000	16,468,700	1,433,000	19,406,700	14,596,000	156,000	52,000	14,804,000
6	0	627,021	62,555	689,576	1,092,500	234,940	88,065	1,415,505
7	0	3,707,070	80,024	3,787,094	1,203,000	6,700	291,500	1,501,200
8	185,000	3,309,100	705,400	4,199,500	0	350,000	0	350,000
9	0	376,000	435,000	811,000	0	592,000	548,000	1,140,000
10	177,600	515,163	140,450	833,213	268,500	0	0	268,500
11	1,540,198	117,865	218,985	1,877,048	2,371,738	332,350	240,542	2,944,630
Purchases	8,190,300	2,086,500	939,000	11,215,800	0	0	0	0
Total	53,891,108	76,081,761	9,441,981	139,414,850	54,777,088	2,869,145	1,443,952	59,090,185

In the quantity collection of seeds, the conifer species of which seeds were collected in greatest quantities consisted of loblolly and slash pines, red cedar, and Rocky Mountain juniper. Hardwood tree seed included especially walnut, oak, tulip poplar, hickory, ash, maple, and hackberry, in the order named. The largest collections of shrub seeds were Russian-olive, Siberian peatree, wild plum, and dogwood. Table 6 summarizes tree- and shrub-seed collections, by regions, for 1937.

TABLE 6.—*Summary of tree and shrub seed collected and purchased, 1937*

Region	Conifers	Hardwoods	Shrubs	Total	Region	Conifers	Hardwoods	Shrubs	Total
	Pounds	*Pounds*	*Pounds*	*Pounds*		*Pounds*	*Pounds*	*Pounds*	*Pounds*
1	2,620	289,206	1,721	293,547	8	3,516	20,966	62,768	87,250
2	20,022	98,980	3,568	122,570	9	3,368	9,215	5,243	17,826
3	1,894	307,792	18,690	328,376	10	657	4,136	2,689	7,482
4	1,462	13,451	24,822	39,735	11	1,007	2,167	11,142	14,316
5	167	169,015	25,172	194,354	Purchases	1,595	54,700	500	56,795
6	21	2,248	2,677	4,946					
7	1,368	368,277	19,721	389,366	Total	37,697	1,340,153	178,713	1,556,563

The nature of nursery work requires that production schedules be planned 2 to 3 years in advance of the time the planting stock will be used on the demonstration areas. Accordingly, seed-collection and nursery-stock-production programs must be planned, executed, and periodically adjusted in close cooperation with the Sections of Woodland Management, Wildlife Management, and Agronomy and Range Management. Very encouraging progress was made during the year in coordinating nursery-production schedules with field operations.

Improvements were made in methods of collecting native seeds; new and special machinery, which reduced unit costs and made possible the harvesting of desirable grasses not heretofore in common use, was devised. The following tabulation lists the grass-seed collections and indicates the quantity of each obtained.

	Pounds		*Pounds*
Grama	83,173	Switchgrass	1,439
Bluestem	44,310	Buffalo	1,282
Dropseed	36,352	Fescue	1,222
Wild-rye	14,761	Rhodes	1,073
Tobosa	6,222	Vine mesquite	1,043
Galleta	6,052	Miscellaneous (44 species)	18,668
Western wheatgrass	1,904		
Bush muhly	1,505	Total	219,006

In addition to the collections listed above, 171,530 pounds of western wheatgrass seed were purchased from farmers in the northern Great Plains area. Various quantities of seed were obtained from several new grasses grown in the nurseries for seed increase, notably two excellent species introduced from South Africa, *Eragrostis curvula* and *E. lehmanniana*, of which 2,606 pounds of seed were harvested.

The 7,434,654 pounds of field and grass seeds purchased through competitive bidding from commercial sources included the following:

	Pounds		*Pounds*
Oats	1,968,910	Redtop grass	56,487
Cowpeas	955,289	Barley	52,260
Rye	751,604	Wheat	41,000
Lespedezas (annual)	502,873	Timothy	38,700
Lespedezas (perennial)	115,995	Millet	32,136
Clovers	532,294	Tall oatgrass	22,300
Sudan grass	366,315	Perennial ryegrass	12,045
Sorghum	344,236	Crotalaria	10,300
Vetch	323,128	Bermuda grass	9,750
Alfalfa	249,085	Carpet grass	8,800
Austrian Winter peas	243,370	Fescue	7,753
Bromegrass	191,505	Reed canary grass	6,890
Orchard grass	102,736	Beans	6,550
Italian ryegrass	99,680	Corn	3,940
Crested wheatgrass	81,661	Zawadke grass	3,040
Slender wheatgrass	73,025	Miscellaneous	28,077
Soybeans	67,246		
Bluegrass	66,439	Total	7,434,654
Dallis grass	59,235		

Several thousand species and variations of native and exotic plants were under observation during the year. A number of them showed excellent characteristics for erosion-control purposes. Of particular note, among those not heretofore in common use, are *Juniperus ashei, Rubus parvifolius, Astragalus rubyi, Pentzia incana, Ephedra sinica, Eragrostic curvula, E. lehmanniana, Agropyron pungens,* and *Hordeum bulbosum,* as well as outstanding strains of the native grasses, such as *Agropyron spicatum, A. inerme, Elymus canadensis, E. glaucus, E. triticoides,* and *Poa ampla.*

Special attention is being devoted to collection and observation of varieties or strains of native grasses. Many of these now showing varying degrees of promise for erosion control have not been cultured previously.

At a number of the nurseries the Bureau of Plant Industry is directing important cooperative research in grass breeding.

RESEARCH

Research work to discover, test, and develop the land-use practices necessary for effective control of erosion and sustained use of soil and moisture resources advanced materially.

Adequate direction of the various phases of the research program was provided by six sections in the Division of Research, each having a well-defined subject matter responsibility, and headed by a specialist in its respective field. Cooperation with State agricultural experiment stations was established through memorandums of understanding.

Research activities involved a series of exploratory studies, research projects, and field tests dealing with specific problems. Projects now in progress within a State, together with those subsequently developed, constitute a State program of soil conservation research. These State programs, together with studies established in consultation with the National Research Council and other agencies, form a national program of research in soil and water conservation.

EXPERIMENT STATIONS

Studies looking to the development of effective, practical, and economical methods for controlling soil erosion were in progress at 13 experiment stations located in as many important agricultural regions of the United States. Six additional stations were being developed to provide information applicable to other regions. The Section of Soil and Water Conservation Experiment Stations also carried on supplemental laboratory studies and special projects at various points throughout the country.

The 13 existing experiment stations, including the 10 operated jointly by the Bureau of Chemistry and Soils and the Bureau of Agricultural Engineering during the period from 1929 to 1935 and transferred to the Soil Conservation Service on April 1, 1935, are located near Guthrie, Okla.; Temple, Tex.; Hays, Kans.; Tyler, Tex.; Bethany, Mo.; Statesville, N. C.; Pullman, Wash.; Clarinda, Iowa; La Crosse, Wis.; Zanesville, Ohio; State College, Pa.; Ithaca, N. Y.; and Mexican Springs, N. Mex.

The principal investigations under way at these stations were directed toward determining the effects of various cropping practices upon run-off and erosion; measuring the effects of different methods of tillage and cultivation; developing more efficient and economical terraces; improving strip-cropping practices; reducing the costs and risks involved in caring for storm waters; improving the farm machinery used in erosion control; developing better methods of gully control; determining proper pasture and range-management practices; developing methods of water conservation and wind-erosion control; and related research.

With the improvement of equipment and technique many old experiments were revised and a number of new ones initiated on the earlier stations. Efforts were made to design all new experiments so that the results obtained would be conclusive and reliable. Replication was introduced wherever necessary. More care was given to the analysis of results and additional data were collected to obtain the utmost value from every experiment.

RESULTS

Detailed reports were prepared setting forth the results obtained at all of those stations where research has been in progress sufficiently long to warrant definite conclusions.

Of these reports, one—Soil and Water Conservation Investigations at the Soil Conservation Experiment Station, Missouri Valley Loess Region, Clarinda, Iowa, Progress Report 1931–35—was published as Technical Bulletin No. 558 of the Department, two others were mimeographed for the use of technical workers, and seven additional progress reports were in the hands of the editors at the close of the year.

Results from all stations demonstrate the remarkable efficiency of close-growing vegetation in reducing run-off and erosion. As a typical example of

the data reported, the measurements of soil and water lost by plots on Clinton silt loam near La Crosse, Wis., are noteworthy. Over a 3-year period the average annual soil loss from a fallow plot amounted to 152 tons per acre. From an identical plot in continuous corn, the corresponding loss was 89 tons per acre. From still another identical plot in bluegrass the loss amounted to only 0.03 ton per acre, a negligible amount. On the same series of plots the average annual run-off of storm water amounted to about 7 inches for both the fallow and corn plots and less than 1 inch for the grass plot. The same relative results were obtained at other stations.

All reports are also in agreement on the value of good crop rotations in any system of erosion control. An experiment carried out at Guthrie, Okla., over the period 1930–35 furnishes an example of the conclusive results obtained, as shown by table 7.

TABLE 7.—*Average annual soil loss and run-off from plots in continuous cotton and in rotation, Vernon fine sandy loam, Guthrie, Okla., 1930–35*

Crop	Average annual soil loss per acre	Average annual run-off as percentage of rainfall
	Tons	*Percent*
Continuous cotton	24.3	14.2
In rotation:		
Cotton	14.3	12.8
Wheat	1.7	14.0
Sweetclover	.6	7.0
Average	5.5	11.3

The report for the Clarinda, Iowa, station shows that the infiltration capacity of soil has a marked influence on the amounts of soil and water lost. The addition of organic matter to the soil increased its porosity and infiltration capacity. This, and other results reported, have immediate practical benefits.

Experiments to determine the effect of different methods of tillage and cultivation were carried out at all experiment stations. Without exception they demonstrated the efficiency and practicability of contour cultivation as a means of reducing run-off and erosion from cultivated lands.

Valuable results were reported in connection with terracing experiments. These data are sufficient to establish, for a number of representative regions, the optimum spacing and grades for broad-base terraces. For all stations in the humid regions the results show, in a general way, the necessity of using drainage-type terraces and the impracticability of level, closed-end terraces.

Experiments in gully control were carried out at nearly all stations. Numerous types of check dams were developed and tested. In addition, the use of vegetative control was greatly advanced.

In addition to the testing of numerous erosion-control measures, much information was obtained on the fundamental principles involved in the phenomenon of erosion itself.

The results of the research conducted at the various experiment stations had an important bearing on the development of the operations program of the Service. In consultation and cooperation with staff members of the various State agricultural experiment stations, sites were selected and land had been acquired for the establishment of six new stations during the fiscal year 1936. These sites were selected with a view to establishing stations in important agricultural regions where the soils, topography, climate, and land use were so widely different that the results developed at existing stations were inapplicable. The new station sites are located at Beemerville, N. J.; Athens, Ga.; Dixon Springs, Ill.; Amarillo, Tex.; Marcellus, N. Y.; and McCredie, Mo. During the year, however, owing to budget limitations, the principal effort at these stations was confined to surveys of the areas and the development of a research program for the future. Actual experimental measurements will be under way early in the fiscal year 1938 at Beemerville and Dixon Springs. Complete development of the other four stations will proceed rapidly as additional funds become available.

LABORATORY STUDIES AND SUPPLEMENTARY PROJECTS

It is obviously impossible and impractical to establish experiment stations in every agricultural region or problem area. However, supplementary studies were planned and carried out so that the results obtained at the experiment stations might be carried over to the interregional areas not directly served by the stations. To this end, the Section began studies of the physical and chemical properties of soils which influence erodibility; the infiltration of water into the soil profile and methods of maintaining, or even increasing the infiltration rate; and the effect of certain amendments, such as the addition of lime and organic matter, in increasing the absorption of rainfall and in decreasing the susceptibility to erosion. These studies are designed to reveal the underlying principles of the soil and water relationship so that this information, together with the information developed at the experiment stations on cropping practices, tillage methods, and methods of erosion control will serve as the basis for the development of a program of soil conservation necessary for the establishment of a permanent agriculture. During the year these studies yielded results of particular importance and great practical value.

A definite advance was made in the development of information on the water relations of soils. It has been clearly shown that the behavior of dissimilar soils in response to the same amount of rainfall is in many instances the key to the selection of the most effective and practical kind of erosion-control measures. A field party of the Section working in the Southeast Region found notable differences in the permeability of typical soils as shown in the following tabulation:

Soil:	*Average rate of intake in inches per hour*
Ruston sandy loam, Americus, Ga	2.06
Cecil sandy loam, slightly eroded, Watkinsville, Ga	.55
Cecil sandy clay loam, moderately eroded, Watkinsville, Ga	.42
Cecil clay loam, severely eroded, Watkinsville, Ga	.09
Davidson clay loam, Monticello, Ga	.82
Iredell loam, Lexington, Ga	.01

Further progress was made in the development of improved equipment and techniques for conducting these investigations in the most efficient manner. Equipment for the measurement of the rate of water loss from small controlled plots was developed. Improvements were made in divisors for fractionating the run-off and permitting the measurement of samples rather than of total quantities. Types of recorders were improved and made less costly and more precise.

Some progress also was made in the studies on the control of wind erosion. The initial stages of this investigation indicated the possibility of utilizing the action of wind to level sand dunes resulting from severe wind erosion. Several practices under test for the prevention of wind erosion are very promising, especially contour listing and the seeding of certain species of plants of a low moisture requirement in contour-listed rows and on cloddy plowed land.

Sufficiently high intensities of rainfall to afford an adequate test of the proposed experimental control measures have been provided to a considerable extent by two new procedures. One of these consists of an outdoor hydraulic laboratory where a pond provides a storage supply of water that may be used in subjecting to test various small structures, dams, erosion checks, outlet ditches, and various types of vegetative protection, in a brief period. The high rate of water application may be made at any time desired and the success or failure of the structure for the particular conditions immediately determined.

Equipment for the artificial application of rainfall upon small experimental areas is being developed. It is anticipated that the relative merits of various control measures may be ascertained through the application of high intensities of artificial rain much more quickly than is possible when the experiment depends upon the occurrence of natural rain. A further advantage in this equipment lies in its portability and the possibility it holds of extending the investigations to temporary locations where special problems are found.

WATERSHED INVESTIGATIONS

The activities of the Section of Watershed and Hydrologic Studies were confined largely to the construction and installation of measuring equipment on experimental watersheds previously established in the north Appalachian area near Coshocton, Ohio, and in the Texas blackland area near Waco, Tex.

A temporary field office was set up at Colorado Springs, Colo., to serve as headquarters pending the establishment of experimental watersheds in the central Great Plains area. Investigations and surveys were made in cooperation

with representatives of the State agricultural experiment stations in Colorado, Kansas, and Nebraska for the purpose of selecting representative areas suitable for projects in this area.

In addition to the work on experimental watersheds, the Section is cooperating with the United States Geological Survey in hydrologic studies conducted for the Service on a number of project demonstration areas. It is also developing a series of watershed run-off studies to be conducted in cooperation with the Division of Conservation Operations.

Studies in the experimental watersheds, however, constitute the major work of the Section. The objectives of these studies may be briefly stated as follows: (1) To determine quantitatively the effect of improved land-use and erosion-control practices on soil and water conservation, and the extent to which these improved practices are effective in the control and reduction of floods and in sustaining and augmenting dry-weather stream flow, (2) to collect and interpret data on rates and amounts of run-off resulting from rains of various amounts and intensities on agricultural areas ranging in size from small natural watersheds to those covering 5 to 6 thousand acres.

The problem on the experimental watersheds consists of a detailed and comprehensive study of the action of water from the time it reaches the ground surface as precipitation until it leaves the watershed as surface or underground flow. It includes studies of precipitation, interception, percolation, evaporation, transpiration, surface and underground storage, and rates of land-surface, channel, and underground flow. Contingent upon future developments, the general plan of study consists of (1) evaluating all factors affecting run-off by carefully conducted experimental studies, and (2) tracing the influence of such factors from small to large watersheds.

The progress of preliminary work, construction, and installation of equipment directly concerned with the collection of hydrologic data on the experimental watersheds in Ohio and in Texas is summarized in tables 8, 9, and 10.

TABLE 8.—*Size classification and future land use of a number of subwatersheds*[1] *within the north Appalachian and the Texas blackland experimental watersheds, June 30, 1937*

Subwatersheds within the north Appalachian experimental watershed				Subwatersheds within the Texas blackland experimental watershed			
Number	Range in size of areas	Future land use[2]		Number	Range in size of areas	Future land use[2]	
		Improved	Prevailing			Improved	Prevailing
	Acres	*Number*	*Number*		*Acres*	*Number*	*Number*
9[3]	0.002			0			
21	1.20– 3.81	13	8	12	3	5	7
3	7.00– 8.35	2	1	0			
7	27.3– 75.6	2	5	9	20–76	6	3
8	130– 297	1	7	6	131–319	3	3
5	930– 463	5		1	550	1	
6	950–4,600	6		6	1,080–5,680	6	
1	[4] 5,000		1	0			
1	[5] 15,000		1	0			

[1] Watershed selections within the project are not yet complete and many of the stream-gaging stations and other appurtenances are now under construction.
[2] All watersheds in leased and purchased areas will be continued under prevailing land use for a sufficient length of time to establish characteristic behavior. The watersheds listed as improved are those that are to be subjected to soil- and water-conservation measures after the calibration period. Watersheds on privately owned land will be studied during a calibration period, after which improved land use will be introduced progressively through cooperative agreements.
[3] Lysimeters.
[4] Watershed adjacent to experimental watershed.
[5] The gaging station on this watershed is being operated in cooperation with the U. S. Geological Survey and the Muskingum Watershed Conservancy District.

The Ohio watershed research project cooperated with the Muskingum Watershed Conservancy District in providing reports of rainfall, ground-water conditions, and run-off in the early stages of storms from carefully selected index areas. With this information the district will be able to direct more effectively the operation of its flood-control and water-conservation works. In

return, the district will provide the Service with information that may be used to extend the results of measurements from the Service's experimental watershed to the larger areas under the supervision of the district.

TABLE 9.—*Installations and records on the north Appalachian and the Texas blackland experimental watersheds, June 30, 1937*

Station	Installed		Under construction		In regular operation		Records obtained		Length of maximum record	
	North Appalachian	Texas blackland	North Appalachian	Texas blackland	North Appalachian	Texas blackland	North Appalachian	Texas blackland	North Appalachian	Texas blackland
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Station months*	*Station months*	*Months*	*Months*
Meteorological: [1]										
Standard rain gages	76	99	0	0	76	99	652	867	12	11
Recording rain gages	13	13	0	0	13	13	69	119	10	10
Maximum and minimum thermometers	3	8	0	0	3	8	18	22	6	3
Central meteorological	[2] 1	0	0	1	1	0	7	0	7	0
Run-off and silt sampling: [3]										
Columbus Notch controls (stage recorders, manual sampling)	13	3	0	2	13	3	70	3	7	3
Parshall flumes (stage recorders, manual sampling)	0	2	1	0	0	2	0	1	0	1
Parshall flumes (stage recorders, automatic silt samplers)	2	0	0	2	2	0	6	0	3	0
Ground-water observation:										
Wells, observed daily	5	110	3	10	5	150	275	860	13	11
Wells, recorders	30	2	0	0	30	2	72	4	3	2
Lysimeters:										
In situ type [4]	3	0	6	0	3	0	6	0	2	0
Soil temperature:										
Soil thermographs [5]	3	3	0	0	0	3	0	1	0	1

[1] Standard gages, approximately 1 gage per 75 acres for Ohio; per 55 acres for Texas. Recording gages, approximately 1 gage per 500 acres for Ohio; per 460 acres for Texas. Maximum and minimum thermometers, approximately 1 set per 500 acres for Ohio; per 600 acres for Texas.

[2] Station includes: 1 recording rain gage, 1 microbarograph, 1 station mercurial barometer, 1 sling psychrometer, 1 set of maximum and minimum thermometers, 1 hygrothermograph, 1 thermograph, 1 hail and rain gage, and 8 standard rain gages in various exposures.

[3] Records obtained are continuous gage heights. In addition, approximately 70 and 20 current meter measurements, respectively, have been made for establishing stage-discharge rating curves for the Ohio and Texas watersheds, and approximately 10 silt samplings have been made on the Texas project.

[4] The in situ type lysimeter box is constructed without disturbing the soil. 1 lysimeter on the Ohio project is equipped with a sensitive weighing and recording mechanism.

[5] 3-pen recording thermographs.

TABLE 10.—*Field and map work completed on surveys in the north Appalachian and the Texas blackland experimental watersheds, June 30, 1937*

Surveys [1]	Field work completed		Map work completed	
	North Appalachian (5,690 acres) [2]	Texas blackland (6,530 acres) [2]	North Appalachian (5,690 acres) [2]	Texas blackland (6,530 acres) [2]
	Acres	*Acres*	*Acres*	*Acres*
Detailed topographic	1,090	5,482	1,090	5,482
Channel and soil movement [3]	0	0	0	0
Geologic	7,300	5,482	7,300	5,482
Detailed conservation [3]	[4] 5,250	5,482	[5] 5,250	[5] 5,482
Cover and yield [3]	5,690	6,359	0	6,359
Cropping plans completed for leased and purchased area	[6] 1,090	[7] 841	[6] 1,090	[7] 841

[1] Economic and social surveys are being made on the north Appalachian experimental watershed by the Section of Economics of Soil Conservation in cooperation with Ohio State University, Ohio State Agricultural Experiment Station, and the Bureau of Agricultural Economics, U. S. Department of Agriculture. Similar surveys are planned but not yet approved for the experimental watershed in Texas.
[2] Total areas of the projects are subject to change on completion of the detailed topographic surveys.
[3] These surveys will be made periodically.
[4] The total area to be included in this survey is 6,300 acres, as farm boundaries rather than watershed boundaries are followed.
[5] Preliminary maps only.
[6] 1937 and 1938.
[7] 1937.

COOPERATION WITH THE UNITED STATES GEOLOGICAL SURVEY

The Division of Operations took a more active part in the cooperative research work being conducted by the United States Geological Survey on several Soil Conservation Service demonstration areas. However, these studies remained under the technical supervision of the Section of Watershed and Hydrologic Studies, Division of Research. This work consists of the collection of data on stream flow, silt movement, precipitation, and ground-water elevations on the Service projects at Mankato, Kans., Tarkio-Bethany, Mo., High Point, N. C., Stillwater, Okla., Spartanburg, S. C., Temple, Tex., Pullman, Wash., and La Crosse, Wis. Available funds were not sufficient to continue work on all projects during the whole year.

Analyses of the hydrologic data collected over a period of 2½ years were initiated, and correlations with the physical characteristics of the watersheds and the changes in land use and practices were made the subject of study. It is hoped that a record of hydrologic data will be obtained, from which trends indicative of the effectiveness of the erosion-control program can be established.

WATERSHED RUN-OFF STUDIES

The work on the class B hydrologic stations described in the annual report for 1936 was changed both in scope and procedure. In order to evaluate the work already under way on these studies and to meet the urgent demands for specific hydraulic-design data, arrangements were made during the year between the Division of Conservation Operations and the Division of Research for rainfall run-off studies to be made on small representative watersheds on Service demonstration projects in various parts of the country.

The planning of these studies was developed in close cooperation with regional offices, State coordinators, and units concerned. The experience of conservationists and engineers on the demonstration areas was used to determine the most typical and pressing problems in design in the several regions and to select the most suitable sites for study.

The immediate objectives of these studies are the collection and interpretation of data on rainfall and on the rates and amounts of resulting run-off from drainage areas of the particular size, shape, and other physical characteristics common in the several regions where improved land-use practices have been established for controlling run-off and erosion.

Table 11 lists the six projects approved and initiated during the year, together with the sizes and treatments of the individual drainage areas. Sites were selected for 13 additional projects in other regions and work on these areas will begin in the near future.

TABLE 11.—*Watershed run-off studies*

Region	Location of project	Size of watershed	Land-use and erosion-control practices established
		Acres	
	Bath, N. Y.	11	Strip-cropped to a rotation of potatoes, oats, and clover.
		24	Hay, meadow, and strip-cropped.
		62	General farming.
		2,000	Continuation of class B hydrologic station.
1	Freehold, N. J.	21	Truck farming; to be terraced.
		30	General farming.
		75	Potatoes and general farming.
		91	Continuous potatoes.
	Hagerstown, Md.	11	General farming; terraced.
		19	Corn, wheat, and hay.
		40	Strip crops, pasture, and woodland.
		54	General farming and alfalfa.
5	Edwardsville, Ill.	13	General farming; terraced.
		28	Clean cultivation; nearly level.
		50	Pasture and permanent meadow; hilly.
		282	Mixed use representing larger watersheds.
6	Colorado Springs, Colo.	10	Small grains.
		33	Native grass; headwaters relief.
		41	Native grass; moderate slopes.
		46	Native grass; steep breaks.
	Vega, Tex.	48	Native grass; rough broken land.
		112	Native grass; typical range land.
		143	Mixed—wheatland, native grass, idle.

Run-off from the small agricultural areas used in the watershed studies occurs in most cases only during storm periods. Rising and falling stages change rapidly and peak flows may last but a few minutes. Under such conditions, measurements made by current meters are often unsatisfactory. In turn, this makes it difficult and unreliable to rate stream-flow control devices in the field.

Facilities of the National Hydraulic Laboratory at the United States Bureau of Standards were utilized during the year to develop a new control of the broad-crested weir type whose laboratory rating capacity may be expected to remain unchanged under field conditions. Model tests of this control have been completed and arrangements are being made to test and rate a full-scale installation at the laboratory of the Iowa Institute of Hydraulic Research.

GEOGRAPHIC AND CLIMATIC STUDIES

Research studies in climate, physiography, and erosion history were carried on to determine the cause, nature, and rate of erosion and to establish its relation to floods. The work was observational rather than experimental in character. Field studies of selected areas suffering from serious soil erosion and differing widely in natural environment paralleled statistical studies of climate and library research in erosion history.

CLIMATIC STUDIES

Definite progress was made in general climatic research. A monograph on sources of moisture for precipitation in the United States prepared and submitted for publication has important implications in connection with both soil conservation and flood control.

A study of the rainfall records for Lynchburg, Va., Elkins, W. Va., and Washington, D. C., to determine the relation between maximum rate, duration, and storm amount was completed during the year. Because the correlation between these factors was found to be high, it was necessary to prepare tables from which peak intensity could be determined for storms of known duration and total rainfall. Thus a new method was supplied for utilizing existing cooperative Weather Bureau rainfall records for determining intensities.

Investigations of rainstorm morphology made possible by the detailed field studies in climate initiated in Oklahoma in the autumn of 1935 were continued. It has been found that rainstorms are sufficiently characteristic in size, shape, and structure as well as in life history and behavior to permit of classification. Study of a large number of rainstorms has revealed the limitations in existing methods of determining rainfall intensity-frequence and has

indicated ways in which such determination may be improved. These researches suggest a new approach to the problem of flood hazards and have a definite bearing on the statistical study of the relation between climate and crop yields.

A comprehensive report on the climate of the Great Plains was prepared for the use of the President's Drought Committee.

PHYSIOGRAPHIC RESEARCH

The Service assembled and analyzed information relating to erosion which geologists have obtained during the last few decades. This material is being prepared in a form easily understood by workers in the field of soil conservation and by farmers in general. One bulletin submitted for publication illustrates, in the simplest possible manner, land forms developed by erosion, the major processes by which soil is wasted away, regional differences in erosion resulting from variations in climate, soil, rock type, or land utilization, and normal or geologic erosion as compared with accelerated erosion brought on by human misuse of the land.

EROSION HISTORY

Library and archive studies in erosion history resulted in the publication of Early Erosion Control Practices in Virginia, by A. R. Hall (U. S. Dept. Agr. Misc. Pub. No. 256), and the completion of a manuscript entitled "Erosion and Its Control in Oklahoma Territory." These two studies of the oldest and youngest agricultural areas in this country developed valuable knowledge of the means by which progressive farmers in both regions succeeded in checking erosion on their own lands. Because these methods were in use over long periods of years and under a variety of environmental conditions, they should serve as a check on current erosion-control methods and show the areal applicability of such practices. For the former Oklahoma Territory a comprehensive annotated bibliography has been prepared of erosion-control measures tested locally by practical farmers in the past.

Because the agricultural history of the United States is comparatively short and past experience is limited proportionally, studies of erosion history were extended to include experience in foreign countries where climatic and physiographic conditions resemble those of seriously eroded sections of this country. A library study of erosion history in foreign countries with climates similar to that of the southern Great Plains area was initiated.

REGIONAL STUDIES

At the close of the year an integrated regional study of erosion factors in the Piedmont, including climatic, physiographic, and erosion-history research, was being continued; a report on the principles of gully formation in the South Carolina Piedmont was nearing completion; a study into the relation of stream patterns, slope, and rock type to gully formation and to the distribution of gully types was being carried forward on the South Tyger demonstration project.

On the basis of existing climatic data, the limits of climatic zones occurring in the Piedmont during each year of the period 1900–1936 were plotted. From these data, it is possible to count the number of years during which any given location has experienced specific climatic conditions in the past. For example, if extremely rainy years were experienced 10 times during the 36-year period of observation, they may be expected to occur with the same approximate frequency during any 36-year period.

Erosion history studies were initiated to determine cultural causes of erosion and reasons for the differences in its extent and degree in regions with similar soil and comparable physiographic and climatic conditions. In South Carolina two contrasting areas were selected for comparison: (1) The Dutch Fork where farms are comparatively small, owner-operated, and where crops are more diversified than in any other regions, and (2) Fairfield County, where cotton economy and large plantations have resulted in serious erosion. An intensive investigation of past land utilization was started for the purpose of tracing the history of erosion.

At the climatic field project in Blaine, Kingfisher, and Logan Counties, Okla., more than 24,000 manuscript maps of temperature, wind velocity and direction, relative humidity, and rainfall were made during the period from January 1936 to July 1937. These formed the basis for the study of rainstorm morphology described under climatic research. To aid in determining whether the

distribution of rainstorms is random or has some topographic control, detailed maps were prepared showing elevation, slope, rock type, soil type, and natural vegetation of the area. Likewise, detailed maps showing the production and acre yield of wheat for 1936 and 1937 were compiled to show the effect of the spotty distribution of rainfall. The Oklahoma climatic study was discontinued at the close of the year because of insufficient funds.

In cooperation with the Muskingum Watershed Conservancy District, the Weather Bureau, and the Ohio Works Progress Administration, 500 weather stations, each with a self-recording rain gage, anemometer, wind vane, psychrometer, and thermometers, were installed at approximately 4-mile intervals throughout the 8,000 square miles of the Muskingum Valley, Ohio. This project is of special importance from the standpoint of flood control because the conservancy district in cooperation with the Geological Survey and the Soil Conservation Service operates more than 30 stream-gaging stations and expects ultimately to have in operation 14 flood-control dams and reservoirs. The work of the project includes rainstorm maps made to determine the amount of rainfall and the time of its occurrence on the minor watersheds above the stream-gaging stations. These data will be related to the run-off as measured at the gaging stations in the expectation that it will be possible ultimately to forecast discharge and stream-flow stage from the records of selected rain gages.

Simultaneously studies in erosion history were initiated to trace the historical development of erosion and floods, and to determine the relative suitability of present farm practices for soil conservation and the reduction of flood hazards.

Continuing the work initiated in June 1936, a physiographic field study was made in the Pennyroyal locality of Kentucky, particularly in that part known as the Kentucky karst characterized by great erosion hazards.

Intensive field studies were made in four selected areas. In each area so great a variety of conditions was found that a thorough understanding of the background of soil erosion required a fairly complete regional study. Types of land use were mapped and, for the purpose of determining agricultural trends, a comparison was made with similar maps prepared in 1923. Particular attention was given to the use of erosion-control practices by farmers, and on the land-use maps farm boundaries were noted since cropping systems and erosion conditions often varied greatly from farm to farm. Erosion forms and processes, such as sheet wash and gullies, were mapped in detail, and intensive studies were made of (1) the truncation of the soil profile as compared with undisturbed soils, (2) the development of gullies in level bottom land, induced by "cistern sinks", (3) the effect of exposure on soil erosion (north-facing slopes being less subject to erosion than south), and (4) the problem of the cedar glades where the clearing of the thin, rocky soil and subsequent cultivation have caused serious soil erosion.

A preliminary report on this work was made.

SEDIMENTATION

Much additional evidence was obtained on the damage caused by sedimentation resulting from accelerated soil erosion. Investigations were made by the Section of Sedimentation Studies with particular reference to bottom-land soils and the impairment of water supply, irrigation, power, and flood-control reservoirs. Previous studies on the transportation, distribution, and resulting damages of erosional debris have been insufficient to give an adequate basis for determining policies and planning programs of erosion, flood, and sediment control in the best interests not only of headwater farm and range lands but also of large public and private resources in the path of sediment-depositing floodwaters. The studies now under way, however, are indicating areas where erosion control is most critically needed to protect downstream and valley resources; they are also pointing to and developing new methods applicable to the control of headwater streams and arroyos as well as the large sediment loads which pass through their channels.

RESERVOIR SILTING

Reservoir-silting investigations are designed to provide accurate information on the depletion of the Nation's reservoir storage resources as a result of accelerated soil erosion. In addition to completing as many detailed reservoir surveys as possible in the widest variety of climatic, physiographic, soil, and land-use provinces, and making a correlation of silting rates found in these areas with the watershed characteristics, this phase of research work also

included the compilation of a complete inventory of existing storage resources with widespread tests of silting conditions supplementary to the detailed surveys. Investigations were also made on the character of reservoir sediment.

The 18 detailed surveys already completed include 6 in Kansas, 4 in Illinois, 2 in South Dakota, 2 in Texas, and 1 each in Alabama, Idaho, Montana, and Nebraska. A preliminary tabulation of data from these surveys and three others, for which data were not previously available, are given in table 12. In addition to these surveys, special studies were made of two developments which provide for silt detention and utilization.

TABLE 12.—*Preliminary data from reservoir surveys during the fiscal year 1937*

Reservoir	Location	Period	Age	Original capacity	Original storage per square mile of drainage area	Annual silt accumulation per 100 square miles of drainage area	Annual depletion of storage	Total depletion of storage to date of survey
			Years	*Acre-feet*	*Acre-feet*	*Acre-feet*	*Percent*	*Percent*
High Rock	Salisbury, N. C.	November 1927 to October 1935	7.8	289,432	73.65	45.4	0.62	4.81
Lake Sherwood	Ventura County, Calif.	1905 to March 1936 [1]	31	2,870	179.4	15.6	.09	2.72
Gibraltar	Santa Barbara, Calif.	January 1920 to April 1936	16.25	14,500	72.50	133.10	1.84	29.83
Lake Waco (1936 resurvey)	Waco, Tex.	April 1930 to February 1936	5.9	39,378	23.69	79.0	3.34	19.78
Lake Medina	San Antonio, Tex.	March 1913 to January 1937	23.8	318,703	542.94	44.8	.08	1.97
Lay	Sylacauga, Ala.	December 1913 to May 1936	22.3	156,525	17.23	8.9	.52	11.50
Black Canyon	Emmett, Idaho	June 1924 to June 1936	12	37,954	13.72	12.4	.91	10.88
Lake Decatur	Decatur, Ill.	April 1922 to June 1936	14.2	19,738	21.79	21.9	1.00	14.23
Lake Calhoun	Galva, Ill.	September 1924 to August 1936	11.9	286	21.78	95.2	4.37	52.10
Lake Bracken	Galesburg, Ill.	December 1923 to August 1936	12.7	2,881	323.34	195.85	.61	7.67
West Frankfort	West Frankfort, Ill.	August 1926 to August 1936	10	1,175	310.03	250.66	.81	8.09
Lake Larrabee	Meade County, Kans.	June 1928 to April 1937	8.8	891	49.50	45.6	.91	8.08
Lake Goodwin	Ottawa County, Kans.	April 1929 to April 1937	8	1,001	48.83	43.3	.89	7.09
Santa Fe	August, Kans.	October 1928 to May 1937	8.6	1,741	43.53	42.5	.98	8.39
Mission Lake	Horton, Kans.	May 1924 to May 1937	13.0	1,852	162.46	195.00	1.20	15.60
Lake Olathe	Olathe, Kans.	July 1932 to June 1937	5.1	532	76.00	154.29	2.03	10.34
Lake Eldorado	Eldorado, Kans.	June 1928 to May 1937	8.8	3,213	97.36	45.2	.46	4.08
Wellfleet Lake	Lincoln County, Nebr.	October 1931 to May 1937	5.6	519	11.88	22.4	1.89	10.60
Baker	Baker, Mont.	May 1908 to June 1937	29.1	756	145.95	167.95	1.15	33.60
Lake Hurley	Gettysburg, S. Dak.	December 1932 to June 1937	4.5	1,226	17.51	11.7	.67	3.02
Hayes Lake	Hayes, S. Dak.	March 1933 to June 1937	4.2	629	15.73	29.2	1.86	7.79

[1] Month undetermined.

Ten surveys in the northern Great Plains area so severely affected by the drought of 1936 provided an accurate basis for estimating the life expectancy of thousands of conservation ponds and reservoirs which were built and financed through large Federal contributions during the past 3 years, or which are now under construction. In addition, the surveys were designed to provide a basis for measuring run-off from larger watersheds in relation to total precipitation. This information should aid greatly in the proper design and application of soil conservation measures in this area and should indicate proper size and distribution of future reservoirs for given watersheds.

In connection with the Great Plains surveys, extensive reconnaissance was carried on by two men for 3 months in Kansas, Nebraska, North Dakota, South Dakota, Montana, and Wyoming. In several of these States an inventory of reservoir resources was virtually complete by the end of the year, and considerable data on general silting conditions were available.

The State-wide reconnaissance of Alabama was extended to obtain additional information including recently built reservoirs. A bulletin is now being prepared to show the results of this survey.

In Kansas, Illinois, and Washington cooperative agreements were made for the examination and study of reservoir sediments by the State agricultural experiment stations. In Illinois, the State Water Survey Division also cooperated in the silting investigations and was a party to the cooperative agreement.

Laboratory studies of compaction were continued at the cooperative hydraulic laboratory in Pasadena, Calif., to determine the changes in volume of sediment measured during the field surveys after the lapse of a definite time and through the addition of overlying deposits of sediment. Understanding of the factor of compaction is important to a prediction of the life of a reservoir from data on the extent of silting at any given time. These investigations were based largely on sediment from Gibraltar Reservoir at Santa Barbara, Calif. A report on this work is now being prepared for publication.

A bibliography and abstract record of all American literature on reservoir silting was completed and some of the foreign literature was translated and abstracted.

STREAM AND VALLEY SEDIMENTATION

Preliminary studies of the effects of soil erosion in causing harmful stream and valley sedimentation were continued. On the basis of findings, a project outline for detailed study of this problem was prepared and approved. Negotiations were begun for establishment of cooperative relations with State agricultural experiment stations, and with other units of the Soil Conservation Service, in connection with development of detailed working plans for intensive investigation of typical watersheds in Mississippi, New Mexico, and South Carolina. A preliminary reconnaissance was also made in western Wisconsin, in conjunction with the Section of Economics.

In Mississippi, about 50 test ranges were established across the valleys of the Tallahatchie River and three of its typical tributaries, Tobitubby, Hurricane, and Wilhite Creek. On these ranges numerous borings were made to an average depth of 8 feet to determine the depth of burial of the original valley soil and the nature of the overlying recent sedimentary deposits. About 40 of the ranges were permanently marked, and precise ground-surface profiles taken as a basis for future remeasurement to determine rates of accumulation. About 50 miles of accurate level lines were run to establish vertical control on these ranges, and plane-table maps were made to record the location of ranges and the extent of the valley areas subject to sedimentation. A report on sedimentary conditions in Tobitubby and Hurricane Valleys is now being prepared.

In New Mexico, the studies were concerned with sedimentation in and along the Rio Grande between Albuquerque and the head of Elephant Butte Reservoir. Tributary to this part of the Rio Grande are great areas of range lands which have become subject to excessive erosion during the past three-quarters of a century as a result of increased stock grazing. The river is unable to carry away all the erosional debris delivered to it, and is therefore filling up its bed and flood plain. This progressive elevation of the channel, and of the floodway between recently built levees, aggravates the problems of flood control and valley-land drainage. These problems are already acute in this valley where agriculture is impossible without irrigation.

In the lower 10 miles of the middle Rio Grande Valley, immediately above the head of Elephant Butte Reservoir at San Marcial, precise profiles were taken on 18 ranges which were established by the Bureau of Reclamation, Department of the Interior, at various dates between 1914 and 1926. Between

the San Marcial area and Albuquerque, a distance of about 100 miles, ground-surface profiles were taken on 19 ranges across the valley, all ranges being permanently marked with iron pipe set in concrete. A report on the results of these surveys is in preparation. These studies were made with the cooperation of the Division of Conservation Operations.

Systematic reconnaissance was made of all principal river and creek valleys in the Piedmont section of South Carolina as a basis for selection of typical watersheds for detailed investigation.

Approximately 5,000 sediment samples were collected, mostly from Mississippi, but including several hundred from South Carolina and New Mexico. About 500 of these samples were subjected to mechanical analysis in the sedimentation laboratory of the University of Chicago.

BED-LOAD STUDIES

The sediment which rolls, slides, and bounces along the bed of a stream, technically known as bed load, is one of the most important, and so far unknown, variables in the whole problem of transportation of sediment by streams.

To measure bed load and correlate it with the other variables of stream transportation, the Section began installation of a totally new type of sediment-measuring station in natural streams near Statesville, N. C., Greenville, S. C., and Dadeville, Ala.

Work on these three bed-load measuring stations progressed satisfactorily despite a season of unusually severe floods. Construction work, excluding the actual installation of pumping units, river gates, and other purchased equipment, was almost completed at the end of the year.

COOPERATIVE LABORATORY

A hydraulic laboratory established by the Section during the fiscal year 1936 at Pasadena, Calif., in cooperation with the California Institute of Technology, continued investigations of the fundamental mechanics underlying the hydraulic phenomena involved in soil erosion and its control. This laboratory is studying hydraulics only insofar as that subject is involved in the entrainment, transportation, and deposition of erosional debris. In other words, it is studying the hydraulics of sediment-laden water in contrast with the hydraulics of clear water.

Although much is known of the flow of clear water, knowledge is lacking of its behavior when burdened with a load of erosional debris. Such knowledge is greatly needed for the Soil Conservation Service control programs as it must underlie all methods of handling water carrying such material, whether it be rain water, flood flow, irrigation, or drainage. Although such studies are basic in character they are of immediate practical application in the field of soil-erosion control. The results should be of great value also in such diversified activities as flood control, navigation maintenance, irrigation, beach-erosion problems, and drainage programs.

Much time was devoted to the design and construction of laboratories and the provision of their equipment. All basic construction work at the field laboratory at Mexican Springs, N. Mex., designed for studying the mechanics of arroyo formation, control, and abatement, was completed by November 1936. However, funds were not available to begin the experiment.

At Pasadena the laboratory and its equipment are now practically complete with the exception of the main flume for the study of size reduction of sediment. Experimental work is under way on all problems.

ECONOMIC STUDIES

Research in the economics of soil conservation was formally inaugurated under a special memorandum of understanding with the Bureau of Agricultural Economics.

Organized cooperatively with the Bureau of Agricultural Economics and the State agricultural experiment stations, the Service program of economic research contemplates two major lines of attack: (1) From the private or individual farm-management point of view; and (2) from the standpoint of the general public. The first method of attack is for the purpose of determining for individual farms and for groups of farms the economic and social effects of a soil-conserving system of farming as compared with a soil-depleting system. The second will attempt to determine the extent to which the public will be benefited by soil conservation.

Negotiations were undertaken with the agricultural economists of most States having soil conservation demonstration areas for the development of such cooperative research. As a result of these negotiations, cooperative agreements were signed with 18 States and personnel was appointed and assigned to conduct the essential research in these States.

Farm-management studies, developed as the year advanced, involved generally a retrospective survey of the economic and social conditions in the demonstration areas as a basis for appraising the soil conservation program and for measuring its effects after a period of years.

A beginning was made on a study of the public aspects of soil conservation to measure and evaluate public losses resulting from erosion. Other studies include the erosion history of matched pairs of farms and studies of strip cropping in areas where this practice was in use before the inauguration of the Soil Conservation Service program. In another instance the work involved an economic and social survey preliminary to the initiation of soil conservation demonstration operations.

HILL-CULTURE RESEARCH

Cultivation of slopes is responsible for severe losses of soil and water, yet the financial needs of the farmer are often so urgent that he cannot afford to retire such lands from tillage and devote them to ordinary protective perennial plant covers such as forest or grass crops. Hill-culture research aims to perfect an ecologically correct and economically practicable system of managing erosion-resisting vegetation consisting of superior strains and selections of trees, shrubs, and perennial herbaceous plants.

The purpose is to conserve soil and water on steep lands through systematic development of specialty erosion-control plants and to provide supplemental farm income from specialty plant products of potentially high commercial value.

Another consideration is a diversified food supply on the farm. Hill-culture research is directed toward finding new and better plants for this purpose, and toward developing for these plants profitable uses that will not compete with established domestic crop production and marketing. Because of the broad scope of this project, it is conducted in close cooperation with the Bureau of Plant Industry and other subject-matter bureaus involved, and also with the State agricultural experiment stations.

The Section of Hill Culture Research is undertaking to study and develop a system of hill-culture farming adapted to conditions and needs in the United States. Comprehensive working plans, developed and approved during the year, furnish an essential basis for well-coordinated and sustained cooperative effort in this new field of soil conservation research. Studies on improved methods for economically propagating erosion-control plant selections by vegetative means were initiated in cooperation with the Bureau of Plant Industry. To implement this work, arrangements were completed for construction of a greenhouse and other necessary plant-propagating facilities at the Plant Introduction Garden at Glenn Dale, Md. Propagation of a limited number of known and available improved varieties of black walnuts, wild plums, bush cherries, blueberries, hollies, and highbush cranberries was begun on a tract of land located at the National Agricultural Research Center, Beltsville, Md., and initial steps were taken toward development of this tract as part of a regional hill-culture research project in cooperation with the agricultural experiment stations of Maryland and the other Central Atlantic States. Cooperative research project arrangements were initiated also with the State experiment stations in Iowa, California, and Alabama, where conditions represent the plant-growth and erosion-control problems of large geographic regions.

Preliminary exploratory studies were started on a number of native and introduced erosion-control plants having possibilities for economic improvement. The attempt to establish selection standards through determination of the morphological differences between shipmast locust and common locust was continued, and observational study made of the behavior of 20 strains of locust selected for their apparently superior quality. Through cooperation with the Bureau of Plant Industry, a study of the new virus disease of black locust was initiated.

Search was made for better selections of erosion-control plants other than locust and resulted in finding several worthy of field tests. Among these, a seedless native persimmon and native dry-land blueberries appear promising. There are also a number of native and introduced ground cover plants whose value for erosion-control purposes needs to be determined.

EVALUATION SURVEYS AND FIELD TESTS

Research and operations were brought into immediate working relationship through a series of evaluation studies and field tests in connection with actual operations on the land in demonstration areas. Arrangements for these studies and tests were completed by the research and operations staff in each of the 11 regions, and work was beginning to get under way as the year ended.

These studies will effectively integrate and coordinate research and operations phases of the Service program. Technical problems confronting operations and extension forces will be answered rapidly and soundly. At the same time, they will serve as a guide in selecting problems for more thorough study in the research program. Likewise, a careful analysis of cost records and special cost data on individual control measures will make it possible to evaluate the effectiveness of various practices in economic terms.

Tentative evaluation schedules covering the major practices used generally throughout the country were prepared. They call for information regarding conditions prior to the initiation of each practice, a description of the installation made, an account of the effectiveness of the work, and a delineation of the factors contributing to its success or failure. These schedules will be used in making evaluation surveys of those control measures on which more detailed information is needed.

LIBRARY

There was a notable increase in the use made of the Service library and a growing recognition that it represents the primary source in the Department for reference material on soil and water conservation.

Circulation for the year was 4,395 books and 1,156 periodicals, supplied on 2,628 requests; 93 books were loaned to field offices of the Service; and approximately 25 photostatic reproductions of reference articles were sent to the field each month. Additions to the library amounted to 1,866 items, including 635 books, 337 pamphlets, 856 continuations of journals, and 38 maps.

A mimeographed bimonthly publication, containing current references on soil conservation and related subjects, was first issued in January. The material was selected from current publications and abstracted in readily accessible form. Copies of each issue as it appeared were sent to all Soil Conservation Service offices, to agricultural libraries, and upon request, to other organizations and individuals. In connection with the preparation of this list, a card index of current literature was maintained, both by author and subject.

PUERTO RICO

The Service extended its activities to Puerto Rico with a reconnaissance erosion survey, completed in November 1936. The survey indicated that more than 40 percent of the land on the island had lost over 75 percent of its surface soil by sheet erosion and only 12 percent of the land showed no apparent damage from soil washing.

In addition, previous studies by the University of Puerto Rico showed that approximately 70 percent of the farm population of the island is concentrated upon 14 percent of the total land area. This condition has resulted in a relatively dense agricultural population. It is, therefore, impossible to retire any large amount of steep land from cultivation. Much of the area that is being cropped is on abrupt slopes ranging up to 80 percent in grade.

The specific objectives of the Service program on the island include the following: (1) The development of a comprehensive soil conservation research program in cooperation with the Federal and Insular experiment stations; (2) development of a coordinated demonstration program in cooperation with all interested Federal and Insular agencies; and (3) cooperation with Federal and Insular organizations dealing with public lands, as well as with the Extension Service.

Work initiated during the year included the planning and development of demonstration areas and the provision of technical assistance to agencies such as the Puerto Rico Reconstruction Administration. This organization furnished the necessary labor, materials, and equipment while the Soil Conservation Service supplied technical advice. At the close of the year a similar cooperative arrangement was being established with the Extension Service. Agricultural extension agents were selecting sample farms adjacent to project areas, and Service technicians were planning conservation programs suited to the holdings of each owner.

During the fiscal year 1938 a small amount of demonstration work will be continued at Mayaguez and demonstrations will be started at Castaner and La Plata. This work will be conducted partly on selected farms in cooperation with the Extension Service, and partly on the land of cooperators settled on tracts of the Puerto Rico Reconstruction Administration, depending on the availability of labor.

Detailed conservation surveys are now being carried out to provide a fundamental basis for all erosion-control research and operations work on the island.

ADMINISTRATION

The number of permanent and temporary employees in the Service as of June 30, 1937, totaled 952 in the Washington office and 12,379 in the field service. Salaries in the Washington office amounted to a total of $1,771,241, while field salaries and wages totaled $20,987,915.

The funds available and obligations encumbered for the year were as follows:

Funds available:	
Regular appropriation	$24, 869, 265
Emergency appropriations	11, 137, 668
Total	36, 006, 933
Obligations encumbered:	
Regular appropriation	22, 190, 988
Emergency appropriations	9, 828, 831
Total	32, 019, 819

BUSINESS MANAGEMENT

The Division of Business Management made notable advances in strengthening its field staff to provide more efficient business assistance to the various technical sections in the regional and other field offices throughout the country. Guiding policies were established with a view to attaining greater procedural uniformity and insuring compliance with existing laws and regulations governing the obligation and expenditure of funds.

FISCAL

In accordance with plans inaugurated during the previous year, activities involving the disbursement of funds, the maintenance of allotment accounts, and the transaction of related financial matters were decentralized so that, by the close of the year, disbursements for nine of the regional offices were made through field Treasury disbursing officers and Army finance officers, while allotment accounts for these offices are maintained under the general supervision of the Fiscal Section in Washington. By June 30, 1937, plans to place the two remaining regional offices on a similar fiscal basis had been approved by officials of the Department and put into effect.

PROCUREMENT, CONTRACTS, AND SPACE

Close contact was maintained with procurement offices in the field in order to achieve more complete standardization of equipment throughout the Service. In the regional offices greater efforts were made to anticipate needs so as to insure an even flow of procurement work and a constant supply of materials for the technical and administrative staffs. Equipment which had become obsolete or which involved excessive maintenance costs was disposed of in accordance with governmental regulations. The computation of freight rates was simplified, property-record systems in the regional offices and in Washington were made more uniform.

This Section also assisted employees of the Service who invented erosion-control machinery or equipment in preparing patent applications. It supervised the acquisition by direct purchase or condemnation of many parcels of land which were made available for the conduct of experimental work or the establishment of soil conservation nurseries. In cooperation with the Section of Erosion Control Practices, it reviewed all cooperative agreements which involved the expenditure of funds by the Service. A total of 638 accident reports

were investigated and the settlement of claims was facilitated in a large number of cases.

The number of buildings occupied by the Service in the District of Columbia was reduced from 11 to 5, a reduction made possible by the availability of space in buildings owned by the Federal Government and additional space in rented buildings already occupied by the Service.

By the end of the year, filing systems in eight of the regional offices had been brought into conformity with that prevailing in Washington. Throughout the Service efforts were made to standardize filing activities and to simplify classification procedure.

PERSONNEL AND TRAINING

The attention of the Division of Personnel and Training was focused throughout the year upon efforts to improve the organization structure of the Service and to select and train an efficient body of employees. Important additions were made to the staff engaged in personnel administration, both in Washington and in the regional offices. Activities emphasized included accident prevention, certain aspects of training, the proper classification of positions, and the perfection of the procedure established for handling all personnel recommendations, such as wage increases, terminations of services, recruiting, transfers, and other similar actions.

The number of employees having secretarial appointments, most of whom were under civil service, increased from 10,394 on July 1, 1936, to 13,245 on July 1, 1937. These appointments were divided between Emergency Conservation Work appointees, employed in connection with C. C. C. camps assigned to erosion-control work, and regular appointees of the Soil Conservation Service. E. C. W. appointments increased from 4,714 to 4,881, and Soil Conservation Service appointments from 5,680 to 8,364. There were 1,113 separations from the Service due to resignations, while other causes for labor turn-over served to swell the number of personnel recommendations required to fill vacancies as they occurred.

Close cooperation was maintained with the Department and with the Civil Service Commission in the effort to establish and maintain high standards of personnel selection and classification.

Employment of W. P. A. relief labor reached a peak on September 26, 1936, when a total of 23,709 security wage workers were on the pay rolls of the Service. Of these, a substantial number were employed in connection with the drought-relief program. By the first of December, employment from relief funds had diminished to 15,428 and by the close of the fiscal year the total was down to 5,327.

TRAINING

Personnel-training activities enabled members of the technical supervisory staff to carry out a planned and coordinated program of training. Groups of employees having similar interests were brought together at convenient points for conference and instruction. Groups of technical men having similar interests, as well as project chief clerks and other clerical employees, were brought into regional headquarters or gathered at convenient points for special instruction. Special groups of employees were organized for the purpose of intensive training. An example of the latter is offered by several special courses provided for the training of junior assistants to technicians in C. C. C. camps. Approximately 450 such assistants were added to the rolls on the basis of a civil service examination of C. C. C. enrollees. Most of these employees were brought together in small groups for special training and close study of their qualifications by competent supervisors before their final assignments were determined.

In several regions instructional talks were given, in connection with weekly seminars, on various aspects of the civil service. Such matters as retirement, recent statutes governing annual and sick leave and their accumulations, provisions tending to bring about security and open opportunities for a career in the Government service, and other similar subjects of general interest to all employees were dealt with.

Appropriate controls were maintained to locate employees available for promotion or transfer and bring their qualifications to the attention of supervisory officers having vacancies to fill. Consistent efforts were made to keep desirable employees in the Service by shifting them from projects where work was being completed to other areas where their services could be used to advantage.

ACCIDENT PREVENTION

Accident-prevention activities initiated in January 1936 were continued. By June 30, 1937, the Service had a responsible officer in each region, either on a full-time or part-time basis, to keep the subject of safety before the project managers, technical foremen, and labor foremen directly responsible for field labor and for the work in garages and repair shops.

Table 13 indicates the substantial reduction in severity and frequency rates brought about in the Service since the accident-prevention activities were undertaken. The injury rates were computed by means of the following equations:

$$\text{Frequency rate} = \frac{\text{Number disabling injuries} \times 1{,}000{,}000}{\text{Number of man-hours of exposure}}$$

$$\text{Severity rate} = \frac{\text{Total time charges} \times 1{,}000}{\text{Number of man-hours of exposure}}.$$

TABLE 13.—*Injury rates*[1] *for Soil Conservation Service field employees and Civilian Conservation Corps enrollees, January 1936 to June 1937*

Employees and rates	January to June 1936	July to December 1936	January to June 1937
Field employees:[2]			
Frequency rates	24.86	17.97	17.55
Severity rates	3.369	.982	.841
Civilian Conservation Corps employees[3]			
Frequency rates	33.56	29.48	21.19

[1] The only injuries included in this table are those arising out of and in the course of employment that incapacitated the employee for a period extending beyond the day or shift on which the accident occurred.
[2] Exclusive of C. C. C. employees.
[3] Only personal injuries sustained while enrollees were under the supervision of the Soil Conservation Service are included.

Pay rolls for the Washington office and certain of the regional offices were prepared by the Division of Personnel and Training. This change resulted in economy of operation and enabled the Service to adopt the policy of having pay rolls prepared in one division and audited in another.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D.C. - - - - - - Price 10 cents

REPORT OF THE SOLICITOR, 1937

United States Department of Agriculture,
Office of the Solicitor,
Washington, D. C., September 14, 1937.

Hon. Henry A. Wallace,
Secretary of Agriculture.

Dear Mr. Secretary: I submit herewith the report of the work of the Office of the Solicitor for the fiscal year ended June 30, 1937.

Respectfully yours,

Mastin G. White, *Solicitor.*

Both the work and the personnel of this office were largely increased during the past year, as a result of the action taken by the President and by yourself in connection with the Resettlement Administration. By Executive Order No. 7530, of December 31, 1936, effective January 1, 1937, all the powers, functions, and duties of that Administration were transferred to you, as Secretary of the Department, and all its funds, personnel, and property were transferred to this Department to be under your supervision and control; and, by your memorandum of January 1, 1937, the Resettlement Administration was made a separate unit of the Department. As a consequence of the action so taken, not only was all the legal work of that Administration transferred to this Office, but there was, necessarily, transferred to it, at the same time, the entire personnel which had theretofore been handling the legal work of that organization, consisting of 46 attorneys in Washington, 49 attorneys in the field, 74 clerical employees in Washington, and 36 clerical employees in the field, making a total increase of 205 in the personnel of this Office.

In the enforcement of those regulatory laws which have been entrusted to this Department for administration and of the regulations promulgated under the authority of such laws, the prosecution of individuals and corporations violating such laws and regulations, is, of course, carried out through the medium of the Department of Justice. It is, therefore, most satisfactory again to report that, in our relations with the representatives of that Department, both those in Washington and those in the field, the cooperation continues to be marked with cordiality and helpfulness.

During the past year the work of the Office has been conducted with economy, expedition, and effectiveness, and there follows a summary thereof, in statistical form, with details concerning some of the work performed under the various statutes involved.

GENERAL SUMMARY OF WORK

During the year more than 1,700 formal, written opinions were rendered to administrative officials. It has not been feasible to keep a record of the legal advice which has been given from day to day, to bureau or other departmental officials, during conferences, by telephone, or by brief, informal opinions written on, or in connection with, papers or proposed correspondence or orders referred to this Office for criticism or advise.

Eighteen hundred and twenty notices of judgment were prepared for publication, pursuant to the authority given by the Food and Drugs, Insecticide, Naval Stores, and Federal Caustic Poison Acts.

21221—37—1

Besides the prosecutions hereinafter tabulated in connection with criminal cases, 1,592 decrees of condemnation and forfeiture were entered under the Food and Drugs, Insecticide, and Federal Caustic Poison Acts.

There were prepared, for prosecution by the Attorney General, 1,429 alleged violations of regulatory statutes entrusted to the Department for enforcement.

Table 1 shows the various statutes for violations of which report was made to the Department of Justice, and for which fines and penalties were recovered. Shown also are the amounts of such fines and penalties.

TABLE 1.—*Cases in which fines were recovered*

Law involved	Cases	Fines	Law involved	Cases	Fines
Animal Quarantine Acts	29	$2,965.00	Lacey Act	9	$160.00
28-hour law	173	19,600.00	National forest laws	379	61,749.82
Migratory Bird Treaty Act	522	10,583.00	Food and Drugs Act	283	65,716.50
Perishable Agricultural Commodities Act	8	48,280.00	Meat Inspection Act	38	2,166.00
Migratory Bird Conservation Act	1	10.00	Federal Seed Act	16	400.00
Migratory Bird Hunting Stamp Act	74	442.00	Federal Caustic Poison Act	33	575.00
Bird and Animal Reservation Trespass Act	5	70.00	Naval Stores Act	1	100.00
			Insecticide Act	58	3,407.00
			Total	1,629	216,224.32

In addition to the cases listed in table 1, the facts of many apparent violations of these regulatory statutes were submitted to the Office by the administrative officials and were given careful consideration, but the facts submitted were not, and apparently could not be made, sufficient to warrant prosecution, so that such cases were not reported to the Department of Justice.

Table 2 summarizes the number of contracts and leases prepared or examined during the year, except the 9,840 agreements based on the Federal Highway Act and other acts supplemental thereto, which are reported in detail on page 24.

TABLE 2.—*Contracts and leases prepared or examined*

Bureau, division, or office	Contracts	Leases	Total
Agricultural Adjustment Administration	25	65	90
Bureau of Agricultural Economics	11	28	39
Bureau of Agricultural Engineering	2	10	12
Bureau of Animal Industry	8	21	29
Bureau of Biological Survey	15	12	27
Bureau of Chemistry and Soils	2	2	4
Central Supplies	18	0	18
Commodity Exchange Administration	0	2	2
Bureau of Entomology and Plant Quarantine	1	85	86
Food and Drug Administration	4	0	4
Forest Service	2,406	57	2,463
Bureau of Plant Industry	11	5	16
Bureau of Public Roads	3	12	15
Resettlement Administration	2	118	120
Office of the Solicitor	0	17	17
Soil Conservation Service	5	150	155
Weather Bureau	43	23	66
Bureau of Home Economics	1	0	1
Department Library	2	0	2
Division of Purchase, Sales, and Traffic	25	0	25
Motion Pictures	1	0	1
National Agricultural Research Center	4	0	4
Total	2,589	607	3,196

In addition to the items listed in table 2, there were submitted to this Office, for examination as to sufficiency of form and execution, numerous leases and contracts prepared by the various bureaus and by individuals and corporations. These included 1,434 cooperative agreements between the bureaus of the Department and State experiment stations, corporations, and individuals, covering experimental work of various kinds. Not the least important contracts prepared and executed during the year were those covering aerial survey work. The contract specifications in this connection were

worked out in various committee meetings and conferences with the several involved units of this and other departments and the Contract Board of the Procurement Division, Treasury Department, participated in by the regularly accredited representative from this Office. These contracts involved a total expenditure of approximately $2,000,000.

There were also prepared 754 renewals and 65 terminations of leases and contracts, and there were prepared, or examined, 86 bonds covering Department employees, including bonds of 25 disbursing and assistant disbursing officers, 27 collection and assistant collection officers, and 2 milk administrators and 11 market administrators under the Agricultural Adjustment Administration.

In addition to the preparation and examination of the above-tabulated leases and contracts, there were examined, for sufficiency of execution, 287 contract performance bonds, 20 annual bid bonds, 35 bid bonds, 7 bonds to protect the Government against infringement of patents, and 5 bonds to insure the proper accounting for fees collected in connection with the inspection of hay and soybeans. Two bonds were prepared for advances of funds under the act of June 3, 1932, to cover miscellaneous expenses of employees, and 23 bonds were approved covering advances of funds under the Subsistence Expense Act of 1926, for travel and subsistence expenses of employees. This office is no longer passing upon these last-named bonds, as that is now a function of the office of the general counsel of the Treasury Department. It was necessary, in numerous instances, to secure, from home offices of surety companies, ratification of the acts of their agents in executing bonds without authoritiy, as disclosed by the records of the Treasury Department.

In connection with the phase of the work of the Agricultural Adjustment Administration having to do with county agricultural conservation associations, assistance was given in evolving forms of bonds and related instruments covering treasurers of such associations. Subsequently, 2,911 of these bonds, carrying total penalties of $8,135,529, were examined for sufficiency of execution. In the settlement of important questions arising in connection with these bonds, it was necessary, upon several occasions, to send a member of this Office to confer with the home officers of various surety companies in other cities and with the Towner Rating Bureau, of New York City.

During the year, there were handled under the provisions of the act of January 1, 1931 (46 Stat. 1052), 11 claims; under the act of May 27, 1930 (46 Stat. 387), 4 claims; and under the act of April 10, 1928 (45 Stat. 413), 1 claim. As a result of motor-vehicle accidents, involving Department of Agriculture drivers, 115 demands were made on private individuals. Thirty-one of these cases were referred to the Department of Justice for prosecution, and, in three of them, money was collected without the necessity for such action.

From time to time the Treasury Department sends this Office a list of corporations which have filed petitions for reorganization under section 77B of the Bankruptcy Act, copies of which are transmitted to the bureaus with a request that, if there are claims in favor of or against any of the corporations so listed, information be sent to this Office about them.

Numerous claims for money due the United States for such things as inspection fees were also handled by this Office, and a number of bills and acts for the relief of private persons were examined and, as the cases did not come within the purview of existing remedial statutes, they were submitted to Congress direct, and were in turn referred to the Secretary for consideration and report.

Considerable time has been devoted to the giving of advice with regard to the drafting of legislation and the interpretation of various fiscal questions arising in connection with the Soil Conservation and Domestic Allotment Act, as amended, the Appropriation Act of the Department, the Agricultural Adjustment Act, and amendments thereto, and the Emergency Relief Appropriation Act.

The volume of Laws Applicable to the United States Department of Agriculture has been kept up to date by means of a convenient supplement in booklet form.

Various departmental employees who were arrested for traffic violations were represented at their hearings by attorneys from this Office. Such arrests were made while the men were acting within the scope of their employment. A number of civil actions involving Department employees,

which arose as a result of official activities, were examined by this Office, and a few cases, involving misconduct on the part of Department employees, were also given consideration.

NATIONAL ARBORETUM

Congress appropriated $80,000 for the acquisition of additional land for the National Arboretum. This will enable the Bureau of Plant Industry to obtain a considerable amount of land which is desired for completion of the project. The securing of options and other negotiations with the landowners are being carried on by this Office.

BID WORK OF THE DEPARTMENT

Expenditures of approximately $14,000,000 were made in connection with the bid work of the Department. This was slightly less than the amount of like expenditures during 1936, which were twice as high as those of any prior year. The above figure does not include purchases which were made by the bureaus themselves and not in connection with the Division of Purchase, Sales, and Traffic, nor does it include the purchases made by the Resettlement Administration.

COMPTROLLER GENERAL'S DECISIONS

The completely indexed file of the decisions of the Comptroller General has been of great importance in the efficient handling of fiscal questions. Four hundred and five Comptroller General's decisions addressed to the Secretary of Agriculture were received, filed, and indexed during the year. His decisions to departments other than this Department totaled 300. These were also indexed and filed.

The attempt to keep on file all current regulations governing Procurement Divisions procedure and other interdepartmental work has been continued with increasing success.

PATENTS

During the year 188 applications for letters patent on inventions of employees of the Department were acted upon, which was an increase of 45 over the preceding year. These applications covered a wide variety of inventions. During the year 94 applications for letters patent were prepared and 44 patents were allowed by the Patent Office. This was an increase of 39 applications prepared, and an increase of 14 patents allowed, over the preceding fiscal year. There are now pending 114 patent applications prepared and filed through this Office.

Four patent-interference proceedings between applications for letters patent by employees of this Department and applications filed by outside parties have been handled. Three of these interference cases have been concluded favorably to the Department, and one is awaiting the decision of the examiner of interferences.

Extensive investigations, necessitating considerable travel, were also conducted by this Office during the year, relative to possible infringements.

Numerous informal conferences were held with the various examiners of the Patent Office, and responses to actions were prepared and filed.

Many questions bearing on various phases of patent law were considered.

CASES OF INTEREST

The interference case of *Anton K. Weiskittel* v. *Arthur H. Senner*, of this Department, involved an invention for a new and useful attachment for heating apparatus. Letters Patent No. 2060348 were granted Mr. Senner, who dedicated the invention to the free use of the public.

The interference of *Euclid W. Bousquet* v. *Lloyd E. Smith* (Department employee) covers the question of priority involving the use of phenothiazine as an insecticide. Mr. Smith is the senior party in this case. Phenothiazine has been found to be an effective insecticide against certain insects that attack growing fruit and, while it is not injurious to man, as in the case of lead arsenate, it has considerable insecticidal value against chewing insects. Both parties to the interference have taken testimony, briefs in support of the con-

tentions of the respective parties have been prepared and filed, and oral arguments made before the examiner of interferences. This case is now awaiting the decision of the examiner of interferences.

The interference case of *T. Warren Allen and Clarence F. Rogers* v. *Kenneth H. Talbot* and *Theodore C. Thee* v. *Harold V. Pullar and James W. Smith* involves patent no. 1953890, granted Messrs. Allen and Rogers, Department employees, and has to do with certain claims of this patent relative to the method of surfacing roadways. On motion on behalf of the patentees, this Office successfully contended that the interfering parties had no right to make certain of the claims of the patent involved in the interference.

The interference of *T. Warren Allen and Clarence F. Rogers* v. *Kenneth H. Talbot and Theodore C. Thee* involves the same patent as the case last referred to above, with the exception that a different claim of the patent constituted the count in issue. This Office moved to dissolve the interference, and the motion was sustained by the Patent Office.

SMALL CLAIMS ACT

(42 Stat. 1066)

During the year 1,045 claims, in the amount of $306,504.43, filed in the various bureaus under the so-called Small Claims Act of December 28, 1922, were referred to this Office for consideration, representing an increase of 543 cases over the preceding year. These claims involved damages to privately owned property, allegedly arising out of the negligence of Department employees.

Final determination was made on 939 claims, in the total amount of $277,930.54, as follows: 457 claims were disallowed in their entirety, representing an amount claimed of $185,543.67; 325 claims were allowed in their entirety, representing an amount aggregating $20,370.37; 157 claims, involving the sum of $72,016.50, were recommended for partial payment, in the sum of $10,818.80.

Forty-six claims were referred to this Office on appeal, aggregating the sum of $11,969.43. Of this number, one case was readjusted and approved for payment in the amount of $147.55. At the close of the year 197 claims were pending.

Most of the cases referred to arose out of automobile collisions, and were examined in accordance with the law of the State in which each collision occurred. There were numerous cases involving the poisoning of animals and the destruction of property by fire, some of which were particularly difficult of solution.

More than 200 cases involving adjustments and refunds under the Agricultural Adjustment Act were considered, and letters and opinions were written in an attempt to effect appropriate settlements.

FOOD AND DRUGS ACT

(34 Stat. 768)

At the beginning of the year 596 cases were pending in the courts under the Federal Food and Drugs Act. Of these, 216 were criminal and 380 were civil cases. During the year 343 criminal cases, involving 1,489 violations, and 1,604 civil cases, a total of 1,947 cases, were reported to the Department of Justice. There were thus pending during the year 559 criminal cases and 1,984 civil cases, a total of 2,543. There were terminated during the year 319 criminal cases and 1,697 civil cases, a total of 2,016, leaving 240 criminal cases and 287 civil cases pending at the close of the year, or a total of 527.

The 319 criminal cases disposed of were terminated as follows:

Disposition:	*Cases*
Pleas of guilty and fines	226
Pleas of nolo contendere and fines	45
Nolle prosequi or dismissal	33
Verdicts of guilty and fines	11
Verdict of not guilty	1
Pleas of guilty; imposition of sentence suspended	2
Plea of nolo contendere; imposition of fine suspended	1

Fines imposed in criminal cases are shown in table 3.

TABLE 3.—*Fines imposed in criminal cases (exclusive of costs, which were generally assessed) under the Food and Drugs Act, fiscal year 1937*

Cases (number)	Amount of fine	Total	Cases (number)	Amount of fine	Total	Cases (number)	Amount of fine	Total
5	$1.00	$5.00	1	$85.00	$85.00	1	$390.00	$390.00
1	2.00	2.00	30	100.00	3 000.00	5	400.00	2,000.00
4	5.00	20.00	3	110.00	330.00	1	480.00	480.00
17	10.00	170.00	2	120.00	240.00	8	500.00	4,000.00
1	11.00	11.00	5	125.00	625.00	1	550.00	550.00
1	12.50	12.50	6	150.00	900.00	1	600.00	600.00
1	15.00	15.00	1	155.00	155.00	2	800.00	1,600.00
5	20.00	100.00	1	170.00	170.00	1	1,000.00	1,000.00
2	24.00	48.00	1	180.00	180.00	1	1,200.00	1,200.00
44	25.00	1,100.00	25	200.00	5,000.00	1	1,500.00	1,500.00
1	26.00	26.00	3	225.00	675.00	1	2,000.00	2,000.00
1	30.00	35.00	6	250.00	1,500.00	1	4,000.00	4,000.00
1	32.00	32.00	1	255.00	255.00	1	4,800.00	4,800.00
6	40.00	240.00	1	259.00	259.00	1	7,200.00	7,200.00
57	50.00	2,850.00	2	270.00	540.00	1	11,800.00	11,800.00
1	55.00	55.00	1	275.00	275.00			
2	60.00	120.00	8	300.00	2,400.00	Total, 283		65,716.50
1	70.00	70.00	1	301.00	301.00			
6	75.00	450.00	1	350.00	350.00			

The 1,697 civil cases that were disposed of during the year involved products that had been seized as being in violation of the statute. These cases were terminated in the following manner:

Disposition:	*Cases*
Default decrees of destruction	1,086
Consent decrees of destruction	42
Consent decrees, goods released under bond for reconditioning	436
Dismissed (chiefly because no seizure of the goods had been effected)	123
Judgment for the claimant	3
Judgment for the Government	1
Judgment for the Government and goods ordered sold	4
Decrees of condemnation, forfeiture and sale; release of goods under bond refused to claimant	2

Seventeen hundred notices of judgment were prepared and published during the year.

CASES OF INTEREST

The case of *United States of America* v. *48 Dozen Packages, More or Less, of Gauze Bandage*, labeled, in part, "sterilized", that was tried in the district court for the Southern District of New York, on April 15, 1937, is one of special interest because of the legal question presented.

It was charged in the libel that said bandages, which had been shipped in interstate commerce by the Bay Co., Bridgeport, Conn., to Parke, Davis & Co., at New York, N. Y., contained Gram-positive and Gram-negative bacilli capable of growing under aerobic conditions and anaerobic bacteria, and that said bandages were therefore adulterated in violation of the Food and Drugs Act, in that their purity fell below the professed standard and quality under which they were sold, namely, "sterilized." It was further alleged that said bandages were misbranded in violation of the act, in that the word "sterilized" appearing on the packages containing the bandages was false and misleading, because the bandages were not sterilized, in that they contained Gram-positive and Gram-negative bacilli capable of growing under aerobic conditions and anaerobic bacteria. The shipper of the article intervened as claimant in the proceeding and admitted having made the interstate shipment set forth in the libel, and that the article at the time of seizure was unsold. Claimant interposed the defense that a gauze bandage is not a drug within the meaning of the Food and Drugs Act. The trial was begun before the court and a jury, and the Government, after presenting evidence that the bandages in question were not in a sterile condition because of the presence of the bacteria therein, placed on the stand a number of physicians, nurses, and druggists, who testified that gauze bandages are commonly used in the cure, mitigation, and prevention of disease. At the conclusion of the Government's case, each side moved for a directed verdict. The court thereupon dismissed the jury and took the case under advisement. Thereafter, on May 27, 1937, the court rendered an opinion in which it was held that the article was a drug within the meaning of the Food and Drugs Act and was adulterated and misbranded as alleged in the

libel. Subsequently, findings of fact and conclusions of law were filed in said case, and it was decreed that the bandages be destroyed. Claimant has indicated it will appeal.

The case of *United States of America* v. *Master Drugs, Inc., a corporation, and William C. Kalash and John E. VonDorn* was tried in the district court for the District of Nebraska, Omaha Division, on July 28, 1936, before the court sitting as a jury.

This case involved the shipment in interstate commerce by the defendants of a preparation known as "Commanders", that was alleged to be adulterated and misbranded in violation of the Food and Drugs Act. The information consisted of two counts, the first alleging the preparation to be adulterated, in that its strength and purity fell below the professed standard and quality under which it was sold, in that the article was represented as containing all essential vitamins A, B, C, D, E, and G in concentrated form; that they were combined in harmonious proportions; that each capsule was equivalent to vitamin content of 1 spoonful of cod-liver oil, 1 cake of yeast, 1 orange, and 2 pounds of whole wheat; that 1 capsule of the article was equal to many pounds of ordinary food rich in vitamins; whereas, the article did not contain any vitamin C, and contained only an insignificant amount of vitamin B; that each of the capsules was not equivalent to vitamin content of 1 spoonful of cod-liver oil, 1 cake of yeast, 1 orange, and 2 pounds of whole wheat, and the vitamin content of each of the said capsules was not equal to that of many pounds of food rich in vitamins. In the second count, the article was alleged to be misbranded in that the statements, to wit, "Commanders combine the six vitamins, A, B, C, D, E, and G in harmonious proportions * * * Each Commander is equivalent in vitamin content to one spoonful of cold liver oil; one cake of yeast; one orange; two pounds of whole wheat * * * many pounds of ordinary food rich in vitamins would be required to equal the vitamin content of one Commander * * *", "Commanders * * * contain all six essential vitamins A, B, C, D, E, and G in concentrated form", borne on the labeling of the product, were false and misleading because the article did not contain vitamin C, contained only an insignificant amount of vitamin B, and each of the capsules was not equivalent to vitamin content of 1 spoonful of cod-liver oil, 1 cake of yeast, 1 orange, 2 pounds of whole wheat, and the vitamin content of each of the capsules would not equal that of many pounds of food rich in vitamins.

The interstate shipment alleged in the information was admitted by the defendants. The Government placed upon the stand analysts, who testified that the actual vitamin content of the preparation was as alleged in the information, and expert witnesses, who were authorities in the field of vitamin research, and who testified that the aforesaid statements appearing upon the labeling of the article were false in the light of the determinations reached by the Government analysts.

The defendants rested their case upon the proposition that they were not responsible for the labeling of the product, due to the fact that they had purchased the same from the Commander Laboratories, at East St. Louis, Ill., who had guaranteed the label statements complained of to be true. The defendants contended that they were innocent parties, because the manufacturer had issued a written guaranty to them covering the labeling complained of, and that they were immune from prosecution under the provisions of section 9 of the Food and Drugs Act.

The court ruled that the agreement, introduced by the defendants, that had been entered into between them and the manufacturer, while it might enable the defendants to recover in a civil suit for damages against the manufacturer, was not a guaranty within the meaning of the Food and Drugs Act, because the act was not specifically cited therein. Thereupon, the court found the defendants guilty and sentenced them to pay a fine of $400 and costs.

The case of *United States of America* v. *Mrs. Adah Alberty,* trading as Alberty Food Laboratories, was tried in the district court for the Southern District of California, Central Division, before the court and a jury, beginning December 4, 1936, and ended December 10, 1936.

This case involved the shipment in interstate commerce by the defendant of certain preparations known as Calcatine, Liver Cell Salts, or Lebara Organic Pellets, and Anti-Diabetic Vegetable Compound Capsules, that were alleged to be misbranded in violation of the Food and Drugs Act. The information filed in said case consisted of 10 counts and charged that statements appearing

upon the label of said products, regarding their curative and therapeutic effects, were false and fraudulent. The defendant stipulated with the Government that she had made the interstate shipments of said articles of drugs as charged in the information.

Analysts for the Government, who had examined samples of the several remedies subsequent to their shipment, testified that defendant's preparation, Calcatine, consisted essentially of lactose, with faint traces of calcium, phosphate, sodium, potassium, magnesium, and iron compound; that Alberty's Liver Cell Salts and Lebara Organic Pellets, which were identical, consisted essentially of milk sugar, with traces of inorganic salts, principally calcium phosphate, and that Alberty's Anti-Diabetic Vegetable Compound Capsules consisted essentially of plant material, including dried leaves, stems, and roots.

The preparation Calcatine was recommended in its labeling as a treatment for acidosis, indigestion, calcium starvation, diarrhea, brain irritation, and teething in children, and as being effective as a tonic in acute diseases, scrofulous and tubercular tendencies. It was also claimed to be effective as a remedy for the growing organism and as a corrective for constitutional defects. Alberty's Liver Cell Salts was recommended in its labeling as a treatment for malarial disorders, biliousness, diseases of the liver, uric acid diathesis, and for many other serious conditions too numerous to mention, including diabetes and gout. Alberty's Lebara Organic Pellets, which were identical with the Liver Cell Salts, were recommended as a treatment for acidosis, dormant liver, bile secretions, and in clearing the complexion. Alberty's Anti-Diabetic, as the name implies, was for the use of diabetics.

It was the contention of the defendant at the trial that all of her said preparations, with the exception of Alberty's Anti-Diabetic, were homeopathic in their nature. The Government produced expert witnesses, learned in the tenets of both the allopathic and homeopathic schools of medicine, who testified that the curative and therapeutic claims of the defendant, appearing on the labeling of said alleged remedies, were without foundation. It was also shown that the defendant, prior to the shipments in question, was warned by officials of the Food and Drug Administration and by a prominent physician with whom she had consulted that the therapeutic claims she had made for her products were impossible of fulfillment.

In connection with the defendant's allegation upon the labeling of the product Calcatine, that the same was effective as a remedy for the growing organism and as a corrective for constitutional defects, collateral literature, published by defendant, but which did not accompany the goods in transit in interstate commerce, was offered in evidence by the Government in explanation of the meaning of the above-mentioned ambiguous phraseology and to show generally defendant's alleged fraudulent conduct. This evidence was admitted by the court over defendant's objection.

The defendant, in an attempt to show good faith in making said statements upon the labeling of her preparations, in addition to her own testimony, presented the evidence of a number of users of said products that the preparations were useful in the treatment of the diseases for which they were recommended. At the conclusion of the evidence the jury brought in a verdict of guilty as to all 10 counts of the information. After deciding adversely to the defendant, on her motion for a new trial made after the verdict of the jury was returned, the court imposed a fine of $1,000 and costs. The defendant has filed an appeal in the United States Circuit Court of Appeals for the Ninth Circuit, which was pending at the close of the fiscal year, appellant's principal cause of complaint being the ruling of the trial court which permitted collateral advertising, which did not accompany the shipments of her remedies in interstate commerce, to be introduced in evidence by the Government.

The case of *United States of America* v. *John W. White*, trading as Dr. J. W. White, Proprietor of White's Herb Manufacturing & Remedy Co., was tried in the district court for the northern district of Alabama, before the court and a jury, on September 29 and 30, 1936.

This case involved the shipment in interstate commerce by the defendant of a preparation known as Dr. J. W. White's Herb Tonic Compound, and was alleged to be misbranded in violation of the Food and Drugs Act. The information filed in this case consisted of one count and charged that certain statements appearing upon the label of the product regarding its curative and therapeutic effect were false and fraudulent.

The Government called to the stand expert analysts who testified that the product consisted of approximately 99 percent of water and 1 percent of

unidentified plant extractives. Expert chemical testimony was introduced on behalf of the Government to the effect that a product, consisting of approximately 99 percent of water and 1 percent of unidentified plant extractives, was not, in the consensus of present-day medical opinion, in whole or in part, composed of, nor did it contain, ingredients or medicinal agents effective as of any benefit at all as a tonic and system purifier, as an appetizer, as useful in stomach complaints, in liver and kidney ailments, or fine for constipation or indigestion.

The defendant took the stand in his own behalf and claimed to be an Indian medicine man and testified that the formula he was using for this preparation was a secret one which his mother had learned from an Indian medicine man in Oklahoma almost a hundred years before, and that his mother had lived to be 110 years old by regularly taking the product. The defendant identified roots, barks, and herbs that he gathered in the locality and which he claimed were used in making the preparation. He was followed on the stand by a number of satisfied users who claimed to have first resorted to medical treatment from which they derived no benefit, but, after taking a few bottles of Dr. White's Herb Tonic Compound, they were cured of various diseases. The jury returned a verdict of guilty, and the court imposed a fine of $300 and a sentence of 6 months in jail suspended during 5 years' probation, the defendant having been previously convicted of violating the Food and Drugs Act.

The case of *United States of America* v. *45 cartons, more or less, each containing 24 jars, and 41 cartons, more or less, each containing 12 jars or Assorted Strawberry and Raspberry Preserves*, was tried on May 12, 1936, in the district court for the district of Rhode Island to the court, a jury having been waived.

It was alleged in the libel that the product was misbranded, in that the statement on the label, "Pure Strawberry Preserve", was false and misleading and tended to deceive and mislead the purchaser as applied to a product resembling a preserve, but which contained less fruit than a preserve should contain; and, further, in that it was an imitation of and offered for sale under the distinctive name of another article. After seizure of the alleged preserves, the White Gate Products Corporation appeared as claimant and admitted having shipped the product in interstate commerce, but denied that it was misbranded, as alleged in the libel.

At the trial the claimant admitted that a standard preserve should contain at least 45 parts of fruit to each 55 parts of sugar used, and the mixture cooked to a suitable consistency. The sole issues for determination, therefore, were whether or not the product contained the proportion of fruit necessary to entitle it to be called a preserve and whether the Government's method of arriving at the fruit content was accurate. The Government called to the stand expert analysts who testified in detail as to the chemical analysis of the product, and these analysts were followed by expert food chemists, who interpreted the results of such chemical analysis, which interpretation was based on data resulting from analyses of a large number of samples of preserve of known composition and of authentic fruit from the different localities, covering many seasons. The claimant relied on the testimony of three commercial chemists who, although not in possession of data contrary to the Government figures, testified that, because of the variations and seasons and localities, the fruits themselves were not of uniform composition and, therefore, no collection of figures could correctly reflect the amount of fruit used to manufacture the product. The president of the claimant corporation took the stand and detailed his manufacturing processes and formula, but admitted on cross-examination that no test was made of his cold-pack raw material to determine whether it contained the amount of fruit and sugar represented. At the conclusion of the evidence, the court found for the Government.

The trial of the case of *United States of America* v. *Eight 1-gallon cans, six half-gallon cans, and thirteen 1-quart cans, more or less, of alleged olive oil*, which began on June 16 and ended June 23, 1936, in the District Court of the United States for the District of New Hampshire, was before the court and a jury.

It was alleged in the libel that the product was adulterated, in that tea-seed oil had been mixed and packed with the article so as to reduce or lower its quality or strength; and also, in that tea-seed oil had been substituted, in part, for olive oil, which the article purported to be. The libel filed also charged the product to be misbranded in that certain statements and designs appearing on the cans containing the article were false and misleading and tended

to deceive and mislead the purchaser when applied to a product containing tea-seed oil; misbranding was further charged, in that it was offered for sale under the distinctive name of another article, to wit, olive oil.

After seizure, the Cosmos Food Stores, Inc., appeared as claimant and admitted having shipped the product in interstate commerce, but denied that it was adulterated or misbranded as alleged in the libel.

This case was the first case tried against manufacturers who were adulterating olive oil with tea-seed oil and was the first case in which the so-called Fitelson test, which was developed expressly to prove this type of adulteration, was demonstrated. The sole question involved in the case was whether or not the so-called Fitelson test was specific and reliable to prove the presence of tea-seed oil in olive oil. Tea-seed oil has been known and used in this country for a great many years in the textile and paint industries, and is imported in its crude state, principally from China. The oil is extracted from the nut or seed of a plant closely related to the beverage tea plant, and its use as an edible oil, after being refined, is a comparatively new one. The cost of tea-seed oil is approximately one-half that of olive oil, and, when analyzed chemically by the then-known methods, the constants for tea-seed oil and olive oil fell within the same range and, consequently, it was impossible, before the Fitelson test was developed, to determine whether the oil was olive oil or a mixture of olive oil and tea-seed oil.

The principal Government witness was the chemist who worked the test out, and, using chemical laboratory equipment, the test was demonstrated in court before the judge and jury. Chemicals were applied to pure olive oil of known Italian origin, and no perceptible change in the color of the oil took place. The same chemicals were then applied to a known mixture of 25 percent of olive oil and 75 percent of refined tea-seed oil; at the same time a sample of the oil under seizure was tested; and, in both instances, the color of the oil in the test tube, upon the application of the chemicals, changed from a deep green to a brilliant red. The test as applied to pure olive oil, a known mixture of olive oil and tea-seed oil, and the oil under seizure, conclusively demonstrated to the jury that the oil under seizure was adulterated and misbranded. The jury found for the Government.

FEDERAL SEED ACT

(37 Stat. 506)

At the beginning of the year there were 21 criminal and 18 seizure cases pending under the Federal Seed Act. During the year, 3 criminal and 10 civil cases were reported to the Attorney General. Sixteen of the criminal cases were terminated as follows: 2 by pleas of guilty and the imposition of fines amounting to $400, 10 by nolle prosequi, and 4 by verdicts of not guilty. Twenty-five of the civil cases were terminated—18 by default decrees, 4 by consent decrees and the goods released under bond, and 3 were dismissed. There were pending at the close of the year 8 criminal cases and 3 civil cases, a total of 11.

FEDERAL CAUSTIC POISON ACT

(44 Stat. 1406)

At the beginning of the year 11 criminal cases were pending under the Federal Caustic Poison Act. During the year 4 civil cases and 26 criminal cases were reported to the Attorney General. Thirty-three of the criminal cases were terminated as follows: 31 by pleas of guilty and the imposition of fines amounting to $550, 1 by verdict of guilty and the imposition of a fine of $25, and 1 case was dismissed. The four seizure cases referred to were also terminated during the year by default decrees of destruction. There were pending at the close of the year four criminal cases.

Eighteen notices of judgment were prepared and published during the year.

NAVAL STORES ACT

(42 Stat. 1430)

Three criminal cases were pending under the Naval Stores Act at the beginning of the year. One criminal case was instituted during the year. All these cases have been closed, and no cases were pending at the end of the

year. Three of said cases were dismissed, and the remaining case terminated by a plea of guilty and the imposition of a fine in the amount of $100.

Two notices of judgment were prepared and published during the year.

MEAT INSPECTION ACT

(34 Stat. 1260)

At the beginning of the year 26 cases were pending in the courts under the Meat Inspection Act. During the year 72 additional cases were reported to the Attorney General for prosecution. There were thus pending during the year 98 cases, 60 of which were disposed of as follows: 33 by pleas of guilty, under which fines were imposed; 5 under pleas of nolo contendere, under which fines were imposed; 1 under a plea of guilty with sentence suspended and the defendant placed on probation; 19 were dismissed; and 2 concluded by verdicts of not guilty. Thirty-eight cases were pending at the close of the year.

The fines, imposed as stated above, are shown in table 4.

TABLE 4.—*Fines imposed in meat-inspection cases*

Cases (number)	Fine in each case	Total fines	Cases (number)	Fine in each case	Total fines	Cases (number)	Fine in each case	Total fines
1	$1	$1	1	$30	$302	2	$200	$400
3	5	15	1	35	351	1	250	250
2	10	20	9	50	450			
1	15	15	7	100	700	Total 38		2,166
10	25	250						

INSECTICIDE ACT

(36 Stat. 331)

At the beginning of the year 37 cases were pending under the act, 23 of which were criminal cases and 14 of which were civil or seizure cases. During the year 84 cases were reported to the Attorney General. In 72 cases criminal prosecutions, and in 12 cases civil, or seizure actions against the products, were recommended.

Of the 95 criminal cases pending at the beginning of, or reported during, the year, 67 cases were disposed of as shown in table 5, leaving 28 cases pending at the close of the year.

TABLE 5.—*Disposition of criminal cases under the Insecticide Act, fiscal year 1937*

Cases (number)	Disposition	Fines	Cases (number)	Disposition	Fines
46	Pleas of guilty and fines	$2,457	1	Verdict of not guilty	
12	Pleas of nolo contendere and fines.	950	7	Dismissed or dropped	
1	Plea of guilty—imposition of sentence suspended.		Total 67		$3,407

Of the 26 civil or seizure cases either pending at the beginning of, or reported during, the year, 15 were terminated by the entry of default decrees of condemnation and destruction, 2 by consent decrees of condemnation, followed by the taking of the goods down under bond for reconditioning or relabeling, 1 by consent destruction, and 1 was dismissed, leaving 7 civil or seizure cases pending at the close of the year.

One hundred notices of judgment were prepared and published during the year.

NATIONAL FORESTS

During the year 133 claims to land within the national forests, initiated under the public-lands laws of the United States, were handled by the Office.

Attorneys of the Office participated in the trial of 45 court cases and

handled 323 matters involving general litigation and settlement. There were prepared, or passed upon for legal sufficiency, 2,387 legal papers of various kinds, such as contracts, leases, bonds, etc. There were also handled 1,054 complaints, informations, protests, etc., affecting the national forests, and abstracts of title were examined in 417 cases. A judgment for $26,189.12 in favor of the Government was obtained against a carrier for damages on account of a fire caused by the negligence of the railroad. Attorneys of this Office participated in the trial of 1,042 cases under State laws affecting the forests. Written opinions were rendered in 788 cases, and oral advice was frequently given.

Work for the Forest Service during the year, other than that under the Weeks forestry law, included handling the following cases and other business:

	Number
Claims to lands pending during year	133
Hearings attended	23
Briefs prepared and filed	14
General litigation and settlement	323
Contracts, leases, bonds, etc	2,387
Invitations to bid examined	1,221
Road contracts and bonds	56
Bills, complaints, informations, protests, etc	1,054
Abstracts of title examined	417
Court appearances	45
Written opinions	788
Stipulations	14
Reimbursement for negligence cases	63
Trespasses:	
Grazing	105
Fire	90
Timber	78
Property	97
Occupancy	49
Miscellaneous	56
Cases under State laws	1,042
Total	8,055

The amount of damages sustained and the fines imposed in 379 cases are shown in table 6.

TABLE 6.—*Trespass cases on the national forests in which damages and fines were recovered*

Character of trespass	Cases	Amount of damages	Fines imposed
	Number	*Dollars*	*Dollars*
Grazing	74	7,315.49	----------
Fire	205	38,295.08	2,306.90
Timber	61	7,082.83	497.75
Property	28	866.34	828.90
Occupancy	9	317.00	3,716.95
Miscellaneous	2	522.58	----------
Total	379	54,399.32	7,350.50

CASES OF INTEREST

In *United States* v. *First State Bank of Thompson Falls* (17 F. Supp. 162), Judge Pray, of the United States District Court for Montana, held constitutional a statute of the State of Montana imposing liability for the cost of extinguishing a forest fire upon the person on whose land the fire exists or from whose property the fire spreads, if such person fails to take reasonable steps to control or extinguish the fire. Judgment was for the Government in the sum of $1,163.28, together with interest amounting to $338.60 and costs of the suit.

When the case was referred to him, the United States attorney questioned the constitutionality of the statute, citing a number of cases in support of his belief and stating that in a similar case a State court had sustained a demurrer to the complaint upon the view that the statute was unconstitutional. This Office furnished him with a memorandum of authority in favor of the constitutionality of the act, and he subsequently filed and won the suit. The

case is of great importance to the Forest Service in carrying out its forest-fire program.

In *United States* v. *Chicago, Milwaukee & St. Paul Railroad Co.*, in the United States District Court for Idaho, judgment in the sum of $75,771.05 was recovered by the Government as damages on account of a forest fire that started August 20, 1934, on the railroad company's right-of-way, which crosses lands of the United States in the St. Joseph National Forest. A motion for a new trial was granted, but a compromise was reached under which the company was to pay $26,189.31 to the United States. What the Government will actually get is dependent upon the outcome of proceedings pending against the company in the District Court for the Northern District of Illinois, under section 77B of the act of March 3, 1933, amending the Bankruptcy Act.

PACKERS AND STOCKYARDS ACT

(42 Stat. 159)

At the beginning of the year there were 32 formal docket cases pending. During the year 312 new cases were instituted and 5 were reopened. Final action was taken on 200 of these cases, and 149 cases were pending on June 30, 1937. Of the 312 new cases instituted, 4 involved reasonableness of rates; 34, trade practices and reparation; 7, failure to maintain bond; 7, insolvency; 260, applications for poultry licenses. The five dockets reopened involved reasonableness of rates and a poultry license. Cease-and-desist and suspension orders were issued in 12 dockets; suspension orders in 4; reparation orders in 3; orders prescribing reasonable rates and charges in 9; orders granting licenses in 122; orders denying licenses in 19; orders suspending licenses in 4; orders of dismissal in 24; and miscellaneous orders in 3.

During the year an order was issued requiring the Great Atlantic & Pacific Tea Co. to cease and desist from certain violations of title II of the act. Respondent applied to a Federal circuit court of appeals for an order restraining enforcement of the Secretary's order. The case was pending before the court at the close of the year.

A case instituted during the preceding year in a Federal district court against the Bonner Stock Yards, Fort Smith, Ark., for failure to comply with an order of the Secretary in connection with the bond regulation, was dropped during the year, the defendant having discontinued business.

During the year the Federal district courts imposed penalties on various persons for engaging in the business of handling live poultry in commerce without having obtained a license, as required by title V of the act, for engaging in business.

An informal hearing was held by an examiner of this office at St. Louis, Mo., for the purpose of determining whether the facts would warrant recommendation that St. Louis be designated as a poultry market under the provisions of title V of the act. The matter was pending at the close of the year.

CASES OF INTEREST

The Secretary issued an order prescribing reasonable rates and charges for stockyard services at the Denver Union Stock Yards at Denver, Colo. As a result of a petition filed by the Denver Union Stockyard Co., the Federal district court at Denver, Colo., temporarily enjoined the Secretary's order prescribing reasonable rates and charges for services rendered by it. A hearing on whether the injunction should be made permanent was held before the court on June 22, 1937, and the case is now pending.

A petition was filed by the St. Joseph Stock Yards Co. of St. Joseph, Mo., requesting a modification of its rates and charges, and, after an investigation by the Department, certain modifications were made in the order of the Secretary.

A petition was filed by the Union Stock Yards Co. of Omaha, Nebr., and investigations were made to determine whether the petition for modifications should be granted. No decision had been reached at the close of the year.

The Secretary prescribed reasonable rates and charges for selling and buying livestock on commission at the New Orleans Stock Yards, Arabi, La.

Petitions were filed by the market agencies at the Chicago Union Stock Yards and the National Stock Yards requesting a modification of the orders of the Secretary prescribing rates and charges for selling and buying live-

stock on commission. After investigations, the Secretary modified the orders in certain respects.

Petitions were filed by the market agencies at the Denver Union Stock Yards and the Kansas City Stock Yards requesting modifications in the orders of the Secretary prescribing rates for buying and selling livestock on commission. Investigations are being made and the petitions are pending.

An extensive hearing, involving alleged violations of title II of the act by Swift & Co., was completed during the year, but the case was still pending decision at its close.

During the year an intensive hearing was held involving the rates and charges of the Union Stock Yard & Transit Co., for services rendered by it at the Union Stock Yards, Chicago, Ill., involving over 10,000 pages of testimony and at least 20,000 pages of exhibits. The case was pending at the close of the year.

Further proceedings were carried on in connection with the Kansas City commission rate case, commonly referred to as the "Morgan Case", which was remanded to the Federal District Court at Kansas City, Mo., by the Supreme Court to determine "whether the plaintiffs had a proper hearing" (298 U. S. 468). Testimony of witnesses was taken before the court and by depositions which were read in open court in May 1937. The case was argued orally and briefs were filed.

During the year a hearing was held on an inquiry into the reasonableness of rates and charges for the rental of coops, the cartage of coops, and the loading of coops on trucks in connection with the handling of live poultry in New York, N. Y.

At the close of the last fiscal year there was pending an inquiry as to the reasonableness of the rates and charges for unloading live poultry from cars in New York, N. Y. This case, which was instituted under title V of the act, was of unusual importance, because it involved the reasonableness of charges for services of unloaders who were members of a local labor union which contracted with the unloading contractors to perform the work. The contractors in turn made contracts with the commission merchants for performing the services. Two unloading contractors were the respondents in the original case. After issuing the first order, the Secretary reopened the case, and three other cases of similar character were initiated and consolidated with the original case. The Secretary issued a final order prescribing reasonable charges.

During the year the district court at East St. Louis, Ill., issued an order requiring market agencies at National Stockyards to make refunds of commissions paid by shippers in excess of the schedule of reasonable rates prescribed by the Secretary, and all refunds had been made at the close of the year.

A Federal district court at Philadelphia, Pa., rendered a written opinion in the case involving the application by poultry dealers of that city for a restraining order against the enforcement of the provisions of title V of the Packers and Stockyards Act. The court dismissed the proceedings, holding that the provisions of title V were not unconstitutional, and that the Secretary had not acted in an arbitrary manner in designating Philadelphia as a poultry market.

In all the cases in which orders were issued by the Secretary, the conduct of the cases has been in charge of representatives of this Office through its attorneys and the examiners. In those cases in which the Secretary's orders have become the subject of litigation in the courts, representatives of this Office have cooperated with attorneys in the Department of Justice in the preparation of the cases for trial and in the preparation of briefs.

PERISHABLE AGRICULTURAL COMMODITIES ACT

(46 Stat. 531; 48 Stat. 584; and 49 Stat. 1533)

The Perishable Agricultural Commodities Act has been amended twice. The amendment approved June 19, 1936, broadened the scope of the meaning of unfair competition in trade, and the amendment approved April 13, 1934, provided for a decision without an oral hearing, with the right to appeal to the district court of the United States for the district in which the party complained against is located.

This Office, in cooperation with representatives of the Bureau of Agricultural Economics, drafted a bill with a view to clarifying and strengthening

numerous provisions of the act. This bill was introduced in the House (H. R. 6762), and a favorable report was made thereon. It passed the House substantially in the form recommended by this Office. At the close of the year, it had not been acted upon by the Senate.

The Secretary issued 209 reparation orders and 67 other orders during the year. Twelve licenses became automatically suspended because of failure to pay reparation awards as ordered by the Secretary. Six licenses were ordered revoked and nine ordered suspended. At the close of the year 18,077 produce dealers, commission merchants, and brokers were licensed under the act, an increase of 1,424 during the year.

During the year 28 cases were referred by this Office to the Department of Justice for prosecution which involved operating without a license, in violation of the act, and penalties were assessed in eight cases, in amounts ranging from $30, in a compromise settlement, to $15,800, with a total of $48,280.

The final decisions rendered by the Secretary during the year, with their respective grounds and number, were as follows: rejection without reasonable cause, 110; failure to deliver without reasonable cause, 35; failure truly and correctly to account, 128; false and misleading statements, 2; and action under section 4B, 1.

The character and number of orders issued by the Secretary were: payment of reparation, 209; publication of facts, 217; publication of facts only, 2; revocation of license, 6; suspension of license, 9; dismissal, 48; and reparations awarded, $57,996.44.

During the year 23 cases were appealed, several on the ground that the act was unconstitutional. In no case was such contention sustained.

CASES OF INTEREST

In the case of *C. S. Mayes & Sons* v. *S. Landow Fruit & Produce Co.*, on September 29, 1936, Judge Edward S. Thomas, United States district judge for the District of Connecticut, rendered a memorandum decision in which the decision of the Secretary and the constitutionality of the act were sustained by him. The court held that there was no violation of "either the due process clause of the Constitution, or the mandate guaranteeing the right of trial by jury."

In the case of *George K. Iida, doing business as Pacific Vegetable Packers* v. *A. R. Waite*, Judge John C. Bowen, of the district court for the Western District of Washington, on or about June 21, 1937, overruled a demurrer filed by the defendant attacking the constitutionality of the act. The defendant contended that the act undertook to usurp the functions of the court and to deprive the defendant of a jury trial.

United States v. *George D. Peters* was a case in which a judgment of default was entered in the United States District Court for the Northern District of Illinois, Eastern Division, on May 21, 1937, by Judge Charles E. Woodward, for $15,800, with interest and costs. The court directed that execution be issued on the judgment.

In the case of *Bradford Fruit & Produce Co.* v. *L. M. Kirkpatrick Co.*, Judge Martin, of the United States District Court for the Western District of Tennessee, on October 21, 1936, affirmed the findings and conclusions of the Secretary, rendering judgment on the original award of $1,888.50, with interest, together with an attorney's fee, making a total sum of $2,655.65. This case involved the purchase of five cars of tomatoes shipped in interstate commerce. The Kirkpatrick Co. stopped payment of its check for $1,888.50, claiming that it did so to protect itself against loss on three cars of tomatoes which it had purchased from the Bradford Fruit & Produce Co.

COMMODITY EXCHANGE ACT

(42 Stat. 998; 49 Stat. 1491)

During the year assistance was given to the Commodity Exchange Administration in drafting rules and regulations to be issued under the Commodity Exchange Act, as the rules and regulations under the Grain Futures Act—the former title of the statute—did not cover many of the subjects added by the amendment. A representative of this Office attended open hearings in various parts of the country in which interested parties were heard on the

various phases of future trading that might be affected by the rules and regulations, as well as some such hearings and numerous conferences held in Washington.

CASES OF INTEREST

Three court attacks on the constitutionality of the Commodity Exchange Act were made during the fiscal year. In one case William S. Moore asked the United States District Court for the Northern District of Illinois to restrain the Chicago Mercantile Exchange from complying with, and various Government officials from enforcing, the act. In a second case, James E. Bennett and others asked for similar restraint of the Chicago Board of Trade and Government officials. In each case the court denied a motion for preliminary injunction and dismissed the bill for want of equity. On appeal to the Circuit Court of Appeals for the Seventh Circuit, the cases were heard together, and the decrees of the district court were affirmed. In a third case, the Board of Trade of Kansas City, Mo., asked the United States District Court for the Western District of Missouri to restrain Government officials from enforcing the act. The court refused to grant an injunction and dismissed the bill. On June 10, 1937, the Circuit Court of Appeals for the Eighth Circuit affirmed the decision, holding that various sections of the act attacked by the board of trade were constitutional.

During the year Henry J. Novotny and Daniel A. DeLattre were expelled, and Abraham Arthur Bank, LeMark Lewis, and Fred J. Holzapfel were suspended, from the Chicago Open Board of Trade. All five persons were registered with the Secretary of Agriculture as futures commission merchants, and Novotny and Holzapfel were also registered as floor brokers. As none of these persons reported his expulsions or suspension, as required by rules and regulations issued by the Secretary of Agriculture under the act, the Secretary served a complaint on each of them, and set hearings; but each, in writing, waived hearing and consented to revocation of his registration. Due to insufficiency of the evidence for criminal action, prosecution was not recommended in these cases.

TOBACCO INSPECTION ACT

(49 Stat. 731)

Although the Tobacco Inspection Act was approved August 23, 1935, the 1937 fiscal year was the first year of its operation, and during that time 23 markets were designated by the Secretary as subject to the provisions of the act. Advice and assistance were given the administrative officers in the preparation of necessary notices, forms, and regulations.

CASES OF INTEREST

Immediately following the designation of Darlington, Lake City, and Pimlico, S. C., as markets subject to the act, W. Wesley Singletary and other warehousemen at those markets filed a suit for an injunction to restrain the administrative officers of the Department and the United States attorney from enforcing the provisions of the act. They allege that the act is unconstitutional upon several grounds, the principal ones being that the transactions sought to be regulated are intrastate and not interstate commerce and are not a burden upon interstate commerce; that the statute exceeds the power of Congress; that it is arbitrary and discriminatory; and that it deprives the complainants of their property without due process of law. A temporary restraining order was granted by District Judge Glenn on August 11, 1936. At the same time an order was issued requiring the defendants to show cause why the injunction should not be continued during the pendency of the suit. Attorneys of this Office cooperated with the Department of Justice in preparing an answer, which was filed on behalf of the several defendants. The suit was still pending at the close of the year.

A similar suit was filed in the district court for the Eastern District of North Carolina by D. T. Currin and other warehousemen operating at Oxford, N. C., which had been designated under the act. In that case, opinions were rendered by Judge Meekins on December 9, 1936, and April 19, 1937, holding the act unconstitutional. An appeal has been taken.

The Supreme Court of the United States, in the case of *Townsend* v. *Yeomans*, decided May 24, 1937, had occasion to summarize and consider the provisions of the Tobacco Inspection Act in passing upon the validity of a statute of the State of Georgia which fixes storage rates for tobacco warehousemen operating within that State. It was contended that the Georgia statute was invalid for attempting to regulate transactions in interstate commerce and that it was in conflict with the Federal Tobacco inspection Act. The court pointed out, however, that the Federal statute has a limited objective and that it does not attempt to regulate warehouse charges. "It sought to aid tobacco growers", the court said, "by establishing and promoting the use of standards of classification and by maintaining a Federal inspection service." The court pointed out that Congress found that the farmer had "no definite system of grades of his own", that the buyers used private grading systems of their own which were kept "strictly confidential", that "without Government standards the farmer has no definite guide for sorting his tobacco", and that accordingly "farmers generally are unable to class their tobacco correctly to meet the trade's demands." It was the view of the court that Congress had "carefully restricted its own requirements and did not attempt to interfere with the operation of State laws as to amounts which warehousemen might charge." In view of the attacks that have been made upon the constitutionality of the Tobacco Inspection Act, it is gratifying to note that there is nothing in the court's summary of and comment upon the provisions of the statute to indicate that it has any doubt of its constitutionality.

STANDARD CONTAINER ACT OF 1928

(45 Stat. 685)

In a libel case against the Planters Manufacturing Co., Portsmouth, Va., a great many hampers (about 29,000) which had been seized were released to the manufacturer by the court in July 1936, under a bond for $1,500. The purpose of the arrangement was to enable the company to correct the capacity of the hampers. Upon correction, the hampers were released and the action was dismissed upon the defendant's paying all costs, amounting to $47.75, incurred by the Department in supervising the reworking of the hampers.

In an action against L. Resnick & Sons, a criminal prosecution for the manufacture of 4-quart metal hampers not of the capacity specified in the statute and not within the tolerances allowed by the regulations of the Department, the defendants entered a plea of nolo contendere and were fined $25. In a libel proceeding against 48 of these hampers, the court entered a decree of forfeiture and destruction.

The Supreme Court of the United States handed down a decision December 7, 1936, disposing of the cases against Charles Resnick and Joseph Resnick, partners trading as L. Resnick & Sons, and the Acme Can Co. The case against L. Resnick & Sons was that they had sold for fruits and vegetables a quantity of 2-quart metal hampers which did not comply with the act because they were not of any standard size authorized by the act and did not come within the tolerances authorized by the Secretary of Agriculture. The case against the Acme Can Co. was for the manufacture of the containers involved in the Resnick case. The court held that the act does not extend to hampers other than the nine classes which it specifically names. Two-quart hampers are not among those named, the least of which is of 4-quart capacity. "In the absence of Government regulation", the court said, "the making and selling of containers is without restriction." The absence of express permission was held not to be a prohibition. The court applied the familiar rule that criminal statutes are to be strictly construed in favor of the accused and that they do not extend to cases not covered by the words of the statutes.

PRODUCE AGENCY ACT

(44 Stat. 1355)

The Produce Agency Act is a criminal statute, making it a misdemeanor punishable by fine or imprisonment, or both, for any person, firm, association, or corporation receiving fruits, vegetables, melons, dairy, or poultry products, or any perishable farm products in interstate commerce on behalf of another, to dump or abandon them without reasonable cause; to make any false report

or statement to the consignor concerning their disposal knowingly and with intent to defraud; or to fail truly and correctly to account therefor to the consignor knowingly and with intent to defraud. Since the enactment of the Perishable Agricultural Commodities Act, prosecutions under this act have diminished, as most of the violations relating to accounting are handled under the Perishable Agricultural Commodities Act.

During the year four cases were referred to this Office with a view to prosecution, and seven cases were pending at the beginning of the year. Three cases were referred to the Department of Justice for prosecution, and there were eight cases pending at the end of the year.

UNITED STATES GRAIN STANDARDS ACT

(39 Stat. 482)

Opinions were given the administrative officers on several legal questions arising in the administration of the act.

In cooperation with the United States attorney at Brooklyn, N. Y., it was satisfactorily arranged for licensed inspectors to board a vessel in the harbor there for the purpose of inspecting grain imported from Argentina. The ship's agents were not disposed to allow the licensed inspectors to board the vessel unless they would sign written waivers of any claims that they might have against the vessel for injuries sustained while aboard. An assistant United States attorney explained the Government's position in the matter and the ship's agent allowed the inspectors to board the vessel and perform their work without signing such waivers.

UNITED STATES WAREHOUSE ACT

(39 Stat. 486)

Opinions were rendered to the administrative officers on a number of questions arising in the administration of the statute.

CASES OF INTEREST

The Supreme Court of the United States has again had occasion to give some consideration to the United States Warehouse Act in connection with an attack made upon the validity of a State statute. *Townsend* v. *Yeomans*, decided May 24, 1937, was a case in which the constitutionality of a statute of the State of Georgia, which fixes storage charges for tobacco warehousemen, was questioned. It was contended that the statute was invalid as an attempted regulation of interstate commerce. The court cited earlier decisions in support of the State's right to regulate storage charges, and pointed out that the licensing of a warehouse under the Federal act does not convert the warehouse into an instrumentality of the Federal Government and that, since Congress has not undertaken to fix storage charges, the State is left free to do so. The court once more referred to the Federal act as securing to the National Government a measure of control over those engaged in the business of warehousing.

MIGRATORY BIRD TREATY ACT

(40 Stat. 755)

Four hundred twenty-six cases were referred to the Attorney General by this Office under the act, and 184 new cases were referred directly to the United States attorneys by conservation agents in the field. A total of 733 cases was closed during the year, as follows: 522 convictions; 69 cases dismissed; 9 verdicts of not guilty; 30 defendants adjudged not guilty by court; 25 no true bills found; 34 prosecutions abandoned; 5 cases stricken with leave; 38 nol-prossed; and 1 case closed by death. At the end of the year 324 cases remained open or awaiting final action.

Fines imposed amounted to $10,583, and jail sentences were imposed for a total of 2,586 jail days.

Several of these fines and jail sentences are worty of note: In California there were two for $500 and 6 months each; one of $500 and 4 months; one of $500 and 8 months; one, in Mississippi, was for $750 and 6 months; and two, in Maryland, were for $500 each.

CASES OF INTEREST

The case of *Cerritos Gun Club et al.* v. *Peirson M. Hall, United States attorney,* was a suit for injunction instituted in the district court for the Southern District of California by a group of hunting clubs, seeking to enjoin the law enforcement agencies from enforcing that portion of the Migratory Bird Treaty Act regulations which prohibits the use of grain, salt, or feed as bait for the purpose of attracting migratory birds to the hunter. The complainants alleged that the baiting regulation was void and beyond the power of the Secretary of Agriculture to prescribe; that the regulation was arbitrary, not based on findings of fact; and not prescribed pursuant to the Migratory Bird Treaty Act, especially in that the regulations were not uniform with Canadian regulations; that the complainants had expended large sums of money in the improvement of their lands, thus providing food and water for the survival of waterfowl; and that the regulation would render their lands worthless and cause irreparable damage to them in that it is necessary to place grain on the lands in order to use them for shooting purposes. In a decision of November 18, 1936, District Judge William P. James dismissed the bill of complaint, finding that, in view of the conditions of the Migratory Bird Treaty, it was contemplated that the United States might restrict the taking of edible wild fowl and might create certain closed seasons; that, furthermore, it appears logical that, where an open season is provided, there may be imposed a qualification or condition that, during any open season that is provided, baiting or luring of the wild fowl should not be permitted, since his clearly would result in the taking of a greater number of birds; that, finally, the regulation applies generally throughout the United States. The court cited with approval the cases of *United States* v. *Griffin* (12 F. Supp. 135); *Brandenberg et al.* v. *Doyle* (12 F. Supp. 342); *Shouse et al.* v. *Moore* (11 F. Supp. 784); and also referred to *Thomson et al.* v. *Dana et al.* (52 F. (2d) 759), and *Missouri* v. *Holland,* (252 U. S. 416).

The complainants have appealed from this decision, and the appeal will probably be heard by the United States Circuit Court of Appeals for the Ninth Circuit some time this fall.

The cases of *United States* v. *Witt K. Cochrane* and *United States* v. *William K. Fellows* were criminal prosecutions, instituted in the District Court for the Southern District of Illinois, charging the defendants with hunting wild ducks by means of corn and rye as bait, contrary to the Migratory Bird Treaty Act and regulations thereunder. Convictions were obtained, from which both defendants have appealed. The issues raised for consideration on appeal are as follows:

1. Whether the adoption of the Migratory Bird Treaty gave Congress the power to protect birds by regulating the means by which they may be taken, as well as the power to protect them by a closed season.
2. Whether the regulation prohibiting the hunting of migratory birds by luring them with bait to the hunter is compatible with and reasonably adapted to carry out the purpose and intent of the Migratory Bird Treaty Act.
3. Whether the delegation of authority to the Secretary of Agriculture to make regulations, as contained in the Migratory Bird Treaty Act, is a proper delegation to an administrative officer.
4. Whether the evidence in the case was sufficient to warrant the conviction of the defendants on the charge of hunting migratory birds by means of bait put out, whereby the waterfowl were lured, attracted, or enticed, as charged in the information.

This appeal was heard by the Circuit Court of Appeals for the Seventh Circuit during May 1937, but no decision had been rendered at the close of the year.

UPPER MISSISSIPPI RIVER WILD LIFE AND FISH REFUGE ACT

(43 Stat. 650)

No new cases were reported under this act, and no pending cases were disposed of in the courts. A total of eight cases is still pending.

MIGRATORY BIRD CONSERVATION ACT

(45 Stat. 1222)

Seven new cases were reported under this act to the Department of Justice, three being pending from the previous year; seven cases have been closed; one by a fine of $10; four by placing the defendants on probation for 1 year each; one by a sentence of 30 days in jail; and one was dismissed. Three cases are still pending.

MIGRATORY BIRD HUNTING STAMP ACT

(48 Stat. 451)

Ninety-seven new cases were reported under this act, of which 89 were submitted to the Attorney General by this office and 8 were reported directly to the United States attorneys by enforcement officers. One hundred and nine cases were closed, in 74 of which convictions were obtained, yielding fines aggregating $442, while in 7 of the cases defendants were placed on probation for periods of 3 months to 5 years. Three cases were nol-prossed, 11 were dismissed, 14 closed without prosecution; in three, grand juries reported no bill, and in four defendants were adjudged not guilty. Sixty-eight cases were still pending at the end of the year.

BIRD AND ANIMAL RESERVATION TRESPASS ACT

(Sec. 84 of the Penal Code)

Four new cases were reported under this act, three being forwarded to the Department of Justice through this Office and one reported directly to a United States attorney by conservation officers. Five cases were closed, convictions being obtained in all, yielding fines totalling $70 and one jail sentence of 6 months. Three cases are still pending.

LACEY ACT—REGULATING INTERSTATE COMMERCE IN WILD ANIMALS

(35 Stat. 1139, as amended June 15, 1935, 49 Stat. 380)

Sixteen new cases were reported under this act, of which five were transmitted by this Office to the Department of Justice and 11 were reported directly to United States attorneys by enforcement officers. Nine cases were closed, with convictions in each instance, yielding fines totaling $160 and jail sentences totaling 66 months, while, in one case, an additional fine of $100 and sentence of 6 months were suspended.

ACQUISITION OF LANDS

The legal work incidental to the acquisition of lands by the Department for and on behalf of the United States, for the use of, and administration by, the various bureaus of this Department, was carried on in accordance with the approved acquisition programs. In addition to the regular appropriations for such land acquisitions, funds were made available for the acquisition of lands from the emergency relief acts.

FOREST SERVICE

Weeks Forestry and Clarke-McNary Acts
(36 Stat. 961, 43 Stat. 653)

Under the Weeks forestry law of March 1, 1911, and the Clarke-McNary Act of June 7, 1924, and the amendments and supplements thereto, the National Forest Reservation Commission authorized for purchase from allocated Emergency Relief Funds during the fiscal years 1934, 1935, 1936, and 1937, a total of 11,627,940 acres of land in 31 States and in Puerto Rico, for a total consideration of $39,293,681. Of this total acreage, 7,951,432.98 acres were acquired by direct purchase (deed) and 1,851,976.64 acres by condemnation proceedings. This Office during the year examined and approved title papers covering 3,562,890.80 acres, the total purchase price of which was $13,145,-

479.91. In addition, at the end of said year, there were in the Department of Justice, awaiting final approval, titles to 358,220.53 acres, the titles having been examined by this Office and found to warrant acquisition by direct purchase (deed).

The examination of the titles, due to the character of the lands being acquired, disclosed many defects which could not be cured, making necessary the acquisition of such lands by condemnation proceedings. During the year, the Attorney General, on the request of the Secretary, instituted 526 suits, covering an aggregate of 958,101.48 acres, at a total value of $3,381,909; and 426 suits, covering an aggregate of 815,092.37 acres, at a total value of $2,747,370, were pending in the courts at the close of the year.

The difference between the acreage authorized for acquisition by the Commission and that actually acquired is due to the fact that, upon official survey and careful computation of the acreage of a tract of land offered, it is often found that the actual acreage of a tract is either more or less than that which the vendor believed to be in the tract of land offered by him. In a few instances, it has been necessary to drop acreage, by reason of title complications, overlapping claims, or for administrative reasons.

BUREAU OF BIOLOGICAL SURVEY

During the year there were acquired by this Department, under titles V and VII of the act of Congress approved June 15, 1935 (49 Stat. 378, 384), for the use of and administration by the Bureau of Biological Survey, in furtherance of the Migratory Bird Conservation Act of February 18, 1929 (45 Stat. 1222), 446,484 acres of land and, from the Emergency Relief Act funds allocated for this purpose, 172,760 acres. At the close of the year, there were pending acquisitions involving a total of 525,457 acres.

RESETTLEMENT ADMINISTRATION

This Office has, during the second half of the fiscal year, cooperated with the administrative officials of the Resettlement Administration and with the Department of Justice on legal matters pertaining to the acquisition of lands by direct purchase and by condemnation, and has prepared and submitted to the Department of Justice, under the direction of the Secretary, petitions in condemnation covering 388 suits, involving 1,706 offerings, or an aggregate acreage of 389,876 acres, at a total value of $1,439,997.

OTHER ACQUISITIONS OF LAND

In addition to the foregoing, there were examined by this Office during the year titles to approximately 105 administrative sites, 9 exchanges, 20 donations, 3 Bureau of Plant Industry tracts, and 9 special cases for the Resettlement Administration (prior to the transfer of said Administration to this Department Jan. 1, 1937); and, at the close of the fiscal year, there were pending acquisitions involving 57 such miscellaneous tracts of land, consisting of 38 administrative sites, 12 donations, 3 exchanges, and 4 special cases.

ACTS RELATING TO THE INTERSTATE MOVEMENT OF LIVESTOCK FROM QUARANTINE DISTRICTS, OR PROHIBITING THE INTERSTATE MOVEMENT OF DISEASED LIVESTOCK, ETC.

(23 Stat. 31; 25 Stat. 414; 32 Stat. 791; 33 Stat. 1264)

Five cases were reported to the Attorney General for prosecution under the act of May 29, 1884 (23 Stat. 31), of which one was terminated by a fine of $100 and two by dismissal. Of the cases pending at the close of the preceding fiscal year, two were terminated by fines of $100 each and one by dismissal. There were eight cases pending at the close of the year.

Seventeen cases were reported to the Attorney General for prosecution under the act of February 2, 1903 (32 Stat. 791), of which one was terminated by a fine of $15, seven by fines of $100 each, one by a fine of $150, one by a fine of $200, and two by dismissal. Of the cases pending at the close of the preceding fiscal year, 16 were terminated by fines of $100 each and 2 by dismissal. There were 11 cases pending at the close of the year.

No cases were reported to the Attorney General for prosecution under the act of March 3, 1905 (33 Stat. 1264), and the single case pending at the close of the preceding fiscal year was dismissed.

In all, 22 cases were reported to the Attorney General during the year and 19 were pending at its close. In the enforcement of these laws, 1 case was terminated by a fine of $15, 26 by fines of $100 each, 1 by a fine of $150, and 1 by a fine of $200.

Nine bonds to insure the handling in this country, in accordance with the regulations of the Department, of restricted import animal byproducts were examined during the year.

CASES OF INTEREST

The so-called "Texas cattle dipping cases", *Russell & Tucker, et al., Porter Bros. & Biffle, et al.*, and *Henry Price, et al.*, v. *The United States*, suits which were authorized by acts of Congress approved May 9, 1934 (48 Stat. 1350 and 1352) and which were based on allegations of negligence on the part of Government inspectors in the dipping of cattle in 1918, 1919, and 1922, were finally decided in favor of the plaintiffs by Judge T. Whitfield Davidson, in the United States District Court at Fort Worth, Tex., on September 14, 1936. The total amount of damages awarded was approximately $600,000. Extensive hearings had been held in January, May, and December 1935, at Fort Worth, Tex., and, on December 23, 1935, final arguments were made before Judge Wilson. No decision was handed down for several months and then, in the summer of 1936, Judge Wilson turned the cases over to Judge Davidson, who asked to have the cases reargued before him on September 14, 1936. At the close of this reargument, the judge read his decision finding for the plaintiffs and awarding all the damages asked. The Department of Agriculture was represented at all these hearings and arguments by an attorney from this Office.

Shortly after the court's decision was announced, recommendations were made by the Secretary to the Department of Justice for the appeal of these cases, as having been decided contrary to the evidence and to the requirements of the acts of Congress authorizing the suits. After Judge Davidson had filed his findings of fact and conclusions of law, late in December 1936, several conferences were held in January 1937, and were attended by representatives of this Office and of the Bureau of Animal Industry, by attorneys from the Department of Justice, and by two attorneys for the plaintiffs, for the purpose of discussion of the question of appeals. At these conferences, it was contended, by the representative of this Office, that many of the findings of fact were not in accord with the testimony given at the hearings. Subsequently, the Department of Justice requested that the findings of fact in all three cases be examined in the light of the testimony and that a detailed report be made as to the alleged discrepancies. Such reports were prepared and submitted in the early part of February 1937, and, on February 19, this Office was advised by the Department of Justice that the Solicitor General had authorized appeals to be taken from all three judgments.

TWENTY-EIGHT HOUR LAW

(34 Stat. 607)

Three hundred and five cases were reported to the Attorney General under the 28-hour law. Penalties aggregating $19,600 were recovered in 173 cases. Twenty cases were dismissed and, in five cases, judgments were rendered for the defendants.

Three hundred and twenty-eight cases were pending at the close of the year.

CASE OF INTEREST

In the case of the *United States* v. *Illinois Central Railroad Co.*, tried in the United States District Court for the Eastern District of Louisiana before the court without a jury, it was alleged that the defendant knowingly and willfully confined certain cattle in a car longer than the period permitted by the statute without unloading them for rest, water, and feeding. The defendant admitted that it had confined the animals in the car for the period alleged, but denied that it knowingly and willfully so confined them, saying that their overconfinement was due to the negligent oversight of its night general

yardmaster in failing to give notice of their arrival to its employee who had the duty of unloading the animals, and contending that such negligence was not equivalent to knowledge and willfulness. The district court rendered judgment for the defendant and, on appeal, this decision was sustained by the United States Circuit Court of Appeals for the Fifth Circuit. Just as the fiscal year expired, a petition for a writ of certiorari to the Supreme Court of the United States was authorized by the Solicitor General. This question is of vital importance in the enforcement of the 28-hour law.

PLANT QUARANTINE ACT

(37 Stat. 315)

Prosecution was instituted under this act by the Department of Justice, on a form of information prepared by this Office, against the Pennsylvania Railroad Co., for delivering to a consignee in Washington, without inspection and authorization by an inspector of the Bureau of Entomology and Plant Quarantine, a case of azalea plants, which had been carried interstate from Tennessee into the District of Columbia, in violation of regulation 2 of the regulations governing the movement of plants into and out of the District of Columbia, as authorized by section 15 of the Plant Quarantine Act. This case was pending at the close of the fiscal year.

The Department of Justice also prosecuted the Fight Floral Co., of New York, for the interstate transportation of 40 palms from a point in the regulated area to a point outside thereof, without inspection and certification by an inspector of the Bureau of Entomology and Plant Quarantine. In this case, the defendant pleaded guilty and was fined $50.

Prosecution under the act was instituted directly by appropriate United States attorneys in two cases, on forms of information furnished by this Office, as follows: (1) Against Frank Shippe, of Westerly, R. I., for the interstate transportation of 344 oyster buoy poles from a point in the regulated area to a point outside thereof, without departmental inspection and certification. In this case also the defendant pleaded guilty and was fined $25. He was also given a suspended sentence of 1 month in jail and placed on probation for 6 months. (2) Against Earl Davis, of Knoxville, Tenn., for the interstate shipment of two truckloads of string beans from a point in the regulated area to a point outside thereof, without inspection and certification by an inspector of the Bureau of Entomology and Plant Quarantine. The defendant pleaded guilty and was fined $25.

Four written opinions were given on legal questions raised by the Bureau of Plant Quarantine, and many informal opinions were given in conferences with representatives of that Bureau.

Conferences were held, hearings were attended, and assistance was given in connection with the revision, revocation, or amendment of existing plant quarantines and regulations as follows: Revocation of the Mexican Fruit Fly Quarantine (no. 5); revocation of the White-Pine Blister Rust Quarantine (foreign) (no. 7); revocation of European Pine Shoot Moth Quarantine (no. 20); notice of permit requirement for the entry of certain seeds under Nursery Stock Quarantine (no. 37); removal of restrictions on interstate movement of certain fruits and vegetables, revision and amendment of regulations, under the Japanese Beetle Quarantine (no. 48); revision and amendment of regulations of the Pink Boll Worm Quarantine (no. 52); revocation of Satin Moth Quarantine (no. 53); revision of the regulations of the Fruit and Vegetable Quarantine (no. 56); revision of the Sand, Soil, or Earth with Plants Quarantine (no. 60); revision of the regulations of the Thurberia Weevil Quarantine (no. 61); revision of the regulations of the White-Pine Blister Rust Quarantine (domestic) (no. 63); amendment of the regulations of the Mexican Fruit Worm Quarantine (no. 64); amendment of the regulations of the Dutch Elm Disease Quarantine (no. 71); and amendment of the regulations governing the importation of potatoes into the United States.

Advice was given in connection with the hearings or conferences with reference to the satin moth and the peach mosaic quarantines; the treatment of foreign bulbs on account of bulb pests; the treatment of domestic narcissus bulbs and other known hosts of the bulb nematodes; and the black stem rust quarantine.

FEDERAL HIGHWAY ACT AND SUPPLEMENTAL ACTS

(42 Stat. 212; 46 Stat. 805; 47 Stat. 709; 48 Stat. 195 and 993; 49 Stat. 115)

During the year 1,049 original and 191 revised project statements for Federal-aid road projects approved by the Department were first reviewed to determine whether they were eligible under the law. The amount of Federal funds which these projects will involve is not yet fully determined, as the Federal funds are allocated only as project agreements are entered into for the construction of the individual projects or sections thereof.

During the year 6,628 original project agreements and certificates of approval of plans, specifications, and estimates prepared by the Bureau of Public Roads were reviewed as to their form and sufficiency of execution by the State highway departments and were approved for execution by the Secretary or his authorized representatives. Drafts of 2,884 modifications of project agreements and certificates of approval of plans, specifications, and estimates prepared by the Bureau of Public Roads for execution by the State highway departments and the Secretary or his authorized representatives were similarly reviewed. Project agreements and modifications of agreements were executed during the fiscal year for work estimated to cost $520,396,608.68, which includes funds from regular Federal-aid appropriations, from funds appropriated for expenditure under section 204 of the National Industrial Recovery Act, and from funds made available for highway and grade-crossing projects by section 1 (second paragraph) of the Emergency Relief Appropriation Act of 1935. It also includes a small amount of funds made available by the Works Progress Administration under the Emergency Relief Appropriation Act of 1935 for the repair or reconstruction of roads and bridges made necessary by reason of floods. These agreements include State highway planning projects pursuant to section 11 of the act of June 18, 1934 (48 Stat. 993). They also cover projects which involve the improvement of 19,194.9 miles of road.

In addition to the foregoing, 15 original and 80 modified project agreements and certificates of approval of plans, specifications, and estimates for National Recovery Work Relief projects prepared by the Bureau of Public Roads for execution by the highway departments and the Secretary or his authorized representatives were reviewed as to form and sufficiency of execution by the highway departments. These projects involved construction work on 49.3 miles of road, estimated to cost $1.266,459.50, of which 70 percent was provided by the Federal Emergency Relief Administration for direct payment for labor performed and 30 percent was provided in the form of a grant by the Public Works Administration for payment through the Bureau of Public Roads for materials and items other than labor.

Original project statements were also reviewed during the fiscal year for seven flood relief projects, and original agreements for two such projects were reviewed prior to execution by the Department, involving a total estimated cost of $2,192,407.04 and 12.9 miles of road.

During the year there also were considered and approved by the Department eight original project statements for Federal lands highway projects under the act of June 24, 1930 (46 Stat. 805). There also were 18 original and 27 modified project agreements for Federal lands highway projects involving an estimated cost of $2,070,496.93 for the improvement of 236.5 miles of roadway.

Summarizing the above, there were 9,654 separate sets of project agreement papers handled during the year, involving projects estimated to cost $525,925,-972.15 and providing for construction work on 19,493.6 miles of road.

There also were 109 cooperative agreements between the Department and cooperating agencies for constructing roads within or partly within national forests, and 77 original construction contracts were entered into after advertisement and award for the construction of such roads. All such cooperative agreements and construction contracts were considered as to form, substance, and sufficiency, prior to action thereon by the Department.

MARKETING, MARKETING AGREEMENTS, AND ORDERS

During the year 145 formal opinions were rendered in connection with surplus removal commodity cases, marketing agreements, licenses, orders, miscellaneous office procedure, contracts, individual and litigation cases. These opinions covered the general legal problems involved in the cases of milk, vegetables,

citrus fruits, deciduous-tree fruits, sugar, tobacco, walnuts, nuts, evaporated milk, cattle and sheep, and miscellaneous cases. These were 85 informal inter-office opinions rendered covering construction and interpretation of legal problems arising out of sections 22, 32, and 37 of the act of August 24, 1935 (49 Stat. 750), as amended; sections 2 and 6 of the act of April 7, 1934 (48 Stat. 528); and other related agricultural acts.

In addition to the formal and informal opinions prepared and rendered, numerous conferences on legal matters were held with members of several bureaus of the Department, other offices of the Government, and with private individuals. There were also drafted and reviewed 550 formal documents in connection with marketing agreements, orders, and licenses such as promulgation of marketing agreements and orders; proclamations of base periods; termination or suspensions of marketing agreements, orders, and licenses; designations of control committees, market administrators, etc., and terminations thereof; orders selecting control committee members; and orders of prorate.

During the year there were 43 programs in effect. They included 4 marketing agreements, 9 marketing agreements and orders, 10 marketing agreements and licenses, 4 orders, and 16 licenses covering the commodities of milk, anti-hog-cholera serum, citrus fruits of California, Arizona, and Florida, California deciduous-tree fruits, onions, vegetables, walnuts, watermelons, evaporated milk, prunes, tobacco, bees, alcohol beverage importing and gum turpentine and gum rosin. The marketing agreements and licenses for alcoholic beverages importing industry and gum turpentine and gum rosin processors were inoperative but not terminated.

Twenty-eight hearings were held on marketing agreements and orders and on amendments to marketing agreements and orders. In addition, there were six hearings held on petitions filed by the handlers under the marketing agreements and orders of walnuts, Florida citrus fruit, California deciduous-tree fruit, and Dubuque, Iowa, milk.

Assistance was given to various administrative offices and officers of the Agricultural Adjustment Administration in the preparation and review of delegations of authority amendments, designations of authority covering practically all phases of professional legal work involved in marketing, marketing agreements, orders, licenses, and programs under the Agricultural Adjustment Act and related agricultural acts and amendments.

Assistance was given in all legal matters covering the several diversion programs (removal of surpluses, purchases for relief, etc.). Numerous conferences were held in connection with these programs and all documents in connection therewith were prepared. Considerable work of a legal nature was done in connection with the liquidation of the 1933 cotton producers' pool, and in problems arising out of 1933 cotton option contracts.

Legal assistance was given to the Federal Surplus Commodities Corporation in matters of surpluses, purchases, sales, and other transactions covering seed corn, seed grain, grain, and hides, and, in matters of loans, agreements involving the Commodity Credit Corporation and the Farm Credit Administration. Further assistance was given to the Federal Surplus Commodities Corporation in the general drafting and preparation of numerous documents, agreements, contracts, orders, correspondence, bylaws, and amendments, and in the reviewing of documents for approval.

Assistance was rendered in the construction, interpretation, and distribution of purchases arising out of the Commodities Purchase Section of the Agricultural Adjustment Administration and in the preparation of all legal documents in connection therewith. Assistance was rendered and material was prepared and reviewed on all Agricultural Adjustment Administration matters for the Federal Register.

The continuation of the field office at Berkeley, Calif., rendered the activities of this division more efficient in all the legal matters coming before it. It also expedited and cleared all matters relating to effective marketing agreements, orders, and licenses on the West coast.

Attention was given to the following litigated matters, during the year: Cases arising under marketing agreements and licenses issued under the Agricultural Adjustment Act before the amendments to the act of August 24, 1935; cases arising under orders issued under the act as thus amended; petitions filed by handlers with the Secretary under subsection (15) (A) of section 8c of the act, alleging the invalidity of orders; and miscellaneous cases,

including, for the most part, cases relating to emergency purchases of cattle and hogs.

There were 22 cases relating to marketing agreements and licenses issued under the act prior to the amendments of August 24, 1935, of which 18 were pending at the beginning of the year (13 in the Federal courts and 5 in the State courts), and 4 of which were instituted (in the Federal courts) during the year. All of these cases were closed during the year with the exception of *Godwin-Medlin Co.* v. *Wallace*, in the district court of the United States for the Southern District of Florida. *Bullard* v. *Speh*, in the district court of the United States for the Southern District of Florida, was twice appealed by the control committee to the Circuit Court of Appeals for the Fifth Circuit. The case involved the distribution of funds on hand by the control committee created to administer the gum-turpentine and gum-rosin marketing agreement. No further mention will be made of these 22 cases.

There were 24 cases relating to orders issued under the amendatory act of August 24, 1935, of which 9 were pending at the beginning of the year (8 in the Federal courts and 1 in a State court), and of which 15 were instituted (14 in the Federal courts and 1 in a State court) during the year. Of the cases pending at the beginning of the year, two were closed, and of the cases originating during the year, three were closed. Each of these 24 cases involved the validity of an order issued by the Secretary of Agriculture and of the applicable provisions of the act under which the order was issued.

The separability of the marketing agreement and order provisions of the act, as amended, from the invalidated processing tax and related crop adjustment control provisions of the act was sustained in *Edwards* v. *United States* (U. S. C. C. A., ninth), involving the California citrus order, which affirmed the decree of the district court of the United States for the Southern District of California (Yankwich, J.); *United States* v. *Groobman* (U. S. D. C., S. D. Cal., Yankwich, J.), involving the English walnut order; *United States* v. *Buckley, et al.* (U. S. D. C., N. D. Calif., St. Sure, J.); and *United States* v. *Kovacevich* (U. S. D. C., S. D. Calif., Yankwich, J.), each involving the California deciduous tree fruit order; and *United States* v. *Goldsmith Fruit Co.* (U. S. D. C., S. D. Fla., Holland, J.), involving the Florida citrus order. In each of these cases the order involved, and the applicable provisions of the act pursuant to which the order was issued, were sustained as constitutionally valid. In *United States* v. *Buttrick* (U. S. C. C. A., first), involving the Boston milk order, the court, in reversing the decree of the United States District Court for the District of Massachusetts (Brewster, J.), also upheld the separability of the marketing agreement and order provisions of the amended act and stated that such provisions did not relate to the control of agricultural production. In *Hudson-Duncan & Co.* v. *Wallace* (U. S. D. C., Portland, Oreg., Fee, J.), involving the English walnut order, the court sustained the marketing agreement and order provisions of the act, but held that the order as issued exceeded the authority conferred by the act. The English walnut order, previously sustained in *United States* v. *Groobman, supra*, provided for delivery by handlers to the control board of surplus walnuts which are that portion of walnuts not permitted by the order to be shipped in interstate commerce. Contrary decisions were rendered in *Fosgate, et al.*, v. *Kirkland, et al.* (U. S. D. C., S. D. Fla., Akerman, J.), involving the same Florida citrus order as in *United States* v. *Goldsmith Fruit Co., supra;* and in *Ganley* v. *Wallace* (D. C. for the District of Columbia, Luhring, J.), involving the District of Columbia milk order, in which latter case the court relied upon the decision of the district court in *United States* v. *Buttrick, supra*, now reversed. The Ganley case, together with the companion case of *Leigh* v. *Wallace*, is now pending on appeal in the Court of Appeals for the District of Columbia. In 13 of the 24 cases handlers were enjoined, either by restraining orders or temporary or final injunctions, from violating the provisions of orders.

There were 30 petitions filed with the Secretary by handlers under subsection (15) (A) of section 8c of the amended act, alleging the invalidity of orders issued by the Secretary, one of which petitions was pending at the beginning of the year and 29 of which were filed during the year. Hearings were held, pursuant to general regulations, series D, no. 1, on 26 of these petitions, and findings and rulings of the Secretary were made on 4 of such petitions. Three petitions were dismissed at the request of the petitioners. The order under which the remaining petitions were filed has since been terminated.

Among the miscellaneous cases, *Land-O-Lakes Creamery, Inc.*, v. *United States*, now pending in the Court of Claims, involves a claim for the alleged cost of handling an emergency purchase of butter made by the Agricultural Adjustment Administration in 1933.

LAND POLICY

Work was continued upon the standard State soil conservation districts law, proposed pursuant to the act of April 27, 1935, and the program to have it adopted in the various States. Conferences were held with the administrative officials of the Soil Conservation Service and representatives of State attorneys general and other State agencies concerned, for more than 30 States in Washington and in the field, to prepare adaptations of the standard act which would be appropriate for adoption in these States. Written opinions were issued adapting the standard act to the constitutional and organizational requirements of 17 States. Informal advice with reference to such adaptation was given for 20 additional States. Legislation more or less along the lines of the standard act was adopted at the 1937 sessions of State Legislatures in Arkansas, Colorado, Florida, Georgia, Illinois, Indiana, Kansas, Maryland, Michigan, Minnesota, Nebraska, Nevada, New Jersey, New Mexico, North Carolina, North Dakota, Oklahoma, Pennsylvania, South Carolina, South Dakota, Utah, and Wisconsin. In addition, such legislation was adopted in Texas and Ohio, but the Governors of those States vetoed the respective bills. Opinions discussing the constitutional and other legal problems of the statutes as actually adopted were issued for nine States and are in preparation for the others. Work is now in process in the preparation of adaptation opinions for States which have not yet adopted such legislation, and in the preparation of a standard set of forms for use in the administration of such legislation. The Office is preparing or reviewing correspondence with State officials in States which have adopted such legislation in connection with legal problems under their laws.

Numerous opinions were issued to the Soil Conservation Service on other phases of its work than the program with reference to the standard act. The cooperative agreement with nine Texas wind-erosion districts was renewed. Opinions interpreting the statute under which the Service is functioning, and passing upon the validity of various proposed expenditures, were issued.

The Office was made responsible for the legal work in connection with the report of the President's Great Plains Committee. A full-length discussion of the legal problems involved in 12 types of proposed land-use adjustment and rehabilitation programs was submitted to the Committee and included by the Committee in its report. The report was submitted to Congress by the President on February 10, 1937, and has been published as House of Representatives Document, No. 144, Seventy-fifth Congress, first session.

During the year the Secretary established a Flood Control Advisory Committee and a Flood Control Coordinating Committee to administer the Department's responsibility in making preliminary examinations and surveys of various watersheds for flood-control purposes under the Flood Control Act approved June 22, 1936. This Office has the responsibility for legal work under this program. Numerous written and informal opinions were prepared and issued to the Advisory Committee and Coordinating Committee chairmen on various problems under the statute. Legislation amending the Flood Control Act approved June 22, 1936, in certain necessary particulars was prepared and submitted.

During the year the Secretary of Agriculture established a Secretary's coordinating committee to survey the functions of the Department of Agriculture and recommend methods for achieving better coordination of these programs. The legal work for this committee will be performed in this Office.

Work is now in process in the preparation of a discussion of legal problems relating to land-use adjustment programs, for inclusion in the 1938 Yearbook on Soils. A special report was prepared during the year for the Bureau of Agricultural Economics, discussing the constitutionality of various proposed taxes and regulatory proposals for prevention of runaway speculation in farm lands.

At the request of the chairman of the Secretary's Everglades committee, there was prepared a comprehensive study of the drainage and tax legislation of the State of Florida relating to a proposed reorganization of the Ever-

glades Drainage District area. The Office has continued its study of rural zoning and State planning legislation in the several States. This study is being carried on for the Land Policy Committee of the Department, in cooperation with the National Resources Committee, the Bureau of Agricultural Economics, and the Resettlement Administration. In cooperation with the Resettlement Administration, there was completed a study of the legal status of farm tenants and sharecroppers under the laws of selected agricultural States which were deemed to be typical of the various agricultural regions.

Since the Resettlement Administration was established as a unit of this Department, on January 1, 1937, the legal work for the Land Utilization Division of that Administration has been done in this Office.

There have been prepared, and are now in process of preparation, a series of long-term leases and cooperative agreements, for use in transferring projects or parts of projects to State or local agencies for administration. In some of the Western States, present plans are to utilize cooperative grazing associations as agencies for administering controlled grazing areas. A standard form of lease has been prepared for this purpose, and assistance will be given in organizing the various cooperative grazing associations. A few Executive orders have been prepared transferring projects to other Federal agencies. For example: One Executive order transferred a part of a project to the Federal Bureau of Fisheries; another transferred all park projects to the National Park Service; and another is now in preparation for the transfer of all Indian projects to the Bureau of Indian Affairs. Negotiations have been begun for the inclusion of part of one project within a State game refuge, and part of another project has been leased to the American Legion.

During the course of development work on land-utilization projects it frequently becomes necessary to undertake certain types of construction upon adjoining privately owned land. Numerous easements, licenses, and leases have been prepared, permitting the Government to undertake such work. There have also been prepared contracts for drilling wells, an agreement with the State of Washington for fire control, turpentine leases, easements for the construction of highways, power lines and telephone lines across project properties, leases granting life estates to the former owners of land purchased for projects; and there have been prepared, or reviewed, memoranda of understanding with the Forest Service, Office of Experiment Stations, Bureau of Indian Affairs, and Department of the Interior.

There have been prepared and submitted to the Department of Justice requests for the institution of injunction proceedings to restrain cattle and sheep trespasses, and to restrain the unauthorized cutting of timber from project areas, and a request for the institution of eviction proceedings against the former owner of a tract of land purchased by the Government.

Most of the standard forms now used in connection with land-utilization projects were prepared prior to the date of this report. It has been necessary, however, either to revise or draft the following forms: Recreational permits, cropping and grazing agreements, special licensing agreements, use permits, use and occupancy permits, occupancy and removal permits, and termination notices.

Advice has been given in regard to the authority to accept gifts of land, to exchange lands, to reconvey land erroneously acquired, and to use, for resettlement purposes, land which was acquired for a land-utilization project, and detailed advice has been given in regard to the procedure to be followed in protecting, policing, and patrolling project properties, and in disposing of surplus property located on the various projects.

Considerable correspondence, addressed to the General Accounting Office, has been prepared in regard to problems arising in connection with the acquisition of land, particularly those which involve modification of the contracts of purchase in order to increase the purchase price. Several letters have been prepared to Senators and Congressmen in regard to the effect of land purchases upon local taxing units, including school districts, in regard to plans for the future acquisition of land, and in regard to plans for the administration of project areas A series of executive orders has been prepared, and is now in process of preparation, withdrawing and reserving for the use of the Department of Agriculture, in connection with land-utilization projects, large areas of public domain.

Most of the advice given in connection with the foregoing problems has involved the preparation of formal written opinions. Some of the more impor-

tant opinions may be referred to: Rights and remedies of the Government in connection with cattle trespass upon project areas; exclusive or concurrent jurisdiction over land acquired for land-utilization projects; interference with the rights of the Chippewa Indians by the erection of fences on public domain and Government-owned land; a discussion of various irrigation, drainage, and water problems arising in connection with land-utilization projects.

The Office, upon request, furnished technical assistance in connection with the drafting of title III of the proposed Bankhead-Jones Farm Tenant Act, under which, if it becomes law, the Department will administer a permanent land-conservation and land-utilization program. The Office also prepared reports for submission to congressional committees upon pending legislation, involving flood control, water conservation, national land policies concerning homesteads, regional planning and power authorities, and governmental reorganization.

AGRICULTURAL ADJUSTMENT ACT AND SOIL CONSERVATION AND DOMESTIC ALLOTMENT ACT

(48 Stat. 31; 49 Stat. 163 and 750; 49 Stat. 1148; 49 Stat. 1115; 49 Stat. 1163)

The Office handled all legal matters in connection with the formulation and administration of the 1936 agricultural conservation program, the 1937 agricultural conservation program, the 1936 naval stores conservation program, and the 1937 naval stores conservation program, all under section 8 of the Soil Conservation and Domestic Allotment Act of February 29, 1936. It also did the legal work in connection with the liquidation of the acreage and production adjustment contract programs operated in 1933, 1934, and 1935, under section 8 of the Agricultural Adjustment Act of May 12, 1933, as amended, and in connection with the winding up of matters which arose during the administration of the Bankhead Cotton Control Act of April 21, 1934; the Kerr-Smith Tobacco Control Act of June 28, 1934; and the Potato Act of August 24, 1935; which three acts were repealed on February 10, 1936.

Sugar problems under the Jones-Costigan Act of May 9, 1934, and the supplementary joint resolution approved June 19, 1936, made considerable demands on the time of the Office. The Tobacco Compact Act of April 25, 1936, became only partially operative during the year, so that the problems arising under it during the fiscal year were few, requiring only a limited amount of time and work for their handling.

During the year approximately 500 memoranda were written in connection with the work above described, and about 450 of these were formal opinions given in response to requests from administrative officials of the Agricultural Adjustment Administration. There were also prepared, or assistance was given in the preparation of, 8 general sugar quota regulations; 13 orders of the Secretary; 60 bulletins setting forth terms and conditions of programs, together with 193 supplements and 25 amendments thereto and 15 revisions thereof; 61 forms with 16 supplements thereto for use in the conduct of the several programs; 6 administrative rulings; and some 100 formal documents of other types.

Frequent conferences were held with administrative officials of the Agricultural Adjustment Administration or with representatives of the General Accounting Office, in connection with forms for carrying out the various programs and liquidation activities described above. Conferences were held also with other departments or establishments of the Government cooperating in this work.

A very painstaking study of problems arising under sections 7 to 17 of the Soil Conservation and Domestic Allotment Act was made, and numerous proposed State laws, designed to make effective, through State action, the objectives of section 7 of the act, were examined, and suggestions were made as to provisions best adapted for that purpose. This involved numerous conferences with representatives of State agricultural colleges, State commissioners of agriculture, and other representatives of States or organizations therein considering such legislation. Considerable research was done and a number of opinions prepared on questions relating to specific States or specific problems affecting both the Federal and State legislation bearing upon agricultural conservation programs under sections 7 or 8 of the Soil Conservation and Domestic Allotment Act.

The Office maintained close liaison with and rendered considerable assistance to the Department of Justice and the Treasury Department in connection

with tax questions arising out of the invalidation of the processing-tax provisions of the Agricultural Adjustment Act and litigation arising out of the operation of the Bankhead Cotton Control Act and the Kerr-Smith Tobacco Control Act, or under the tax refund provisions of titles III, IV, and VII of the Revenue Act of 1936. Considerable correspondence has been carried on during the year with reference to these matters.

Pursuant to requests by various Members of Congress, numerous conferences were held between such members and attorneys of this Office, and a great deal of technical assistance was rendered by such attorneys in connection with the drafting of proposed new legislation, particularly the crop insurance bill and the sugar bill.

RESETTLEMENT

(48 Stat. 200; 49 Stat. 115; Public, No. 4, 75th Cong.)

The transfer of the Resettlement Administration to this Department, as of January 1, 1937, made it necessary to make adequate provision in this Office for the rendering of legal advice to that Administration. To accomplish this, there was established a Resettlement Division of the Office, composed of the attorneys and their nonprofessional assistants, who were formerly employed in the general counsel's office of the Resettlement Administration. Where existing divisions in this office were handling legal problems similar to those handled by the Resettlement Administration, such problems were assigned to such divisions and adequate personnel transferred from the Resettlement Division. Thus, maximum efficiency and proper coordination in the general work of the Office were secured.

Because of the wide variety of legal problems handled by the Resettlement Administration, the Resettlement Division of the Office has consisted of three sections: Two of these are concerned with the problems arising from the planning, construction, management, and operations of resettlement communities; the other is concerned with the problems arising out of the rehabilitation loan and grant program of the Resettlement Administration. Since the administrative activities of the Resettlement Administration were to a large extent carried on through regional offices, the Resettlement Division has included 12 regional attorneys with staffs of assistants.

The rehabilitation program of the Resettlement Administration has given rise to a large number of diverse legal questions which have been submitted for solution. It was necessary to draft a large number of different types of legal documents to be used in connection with loans and grants made to individuals and cooperative associations. Also involved was the formulation and the revision, from time to time, of detailed procedures setting forth the terms, conditions, and purposes of the loans. To secure these loans, it was necessary to draft, and frequently revise and modify, 149 forms involving liens on real estate, chattels, and crops. Included among these forms were waiver and nondisturbance agreements and instruments involving the renewal, release, extension, and satisfaction of various obligations to the Resettlement Administration. The diversity of State laws regarding such instruments made it necessary to investigate thoroughly the laws of each State and to draft the forms in conformity with such laws and in such a way as to meet the needs of peculiar local conditions.

The collection of such loans resulted in an increasingly large number of legal problems. In order to prepare a collection procedure, it was necessary to have regard, on the one hand, for Federal laws and regulations regarding the handling of Government funds and, on the other hand, for the diverse laws in the several States with respect to the collection of loans and the foreclosure of security instruments. To meet the differences in local practice, 203 separate forms were drafted for use in handling collection matters. These procedures and forms are embodied in 48 sets of instructions, one for each State, known as liquidation manuals, which are distributed among the personnel of the Resettlement Administration concerned with the making, reporting, or supervision of collections. Changes in the laws of several States have necessitated the revision of these manuals from time to time.

Accounting problems arising out of the individual loan program gave rise to a wide variety of legal questions. These questions were discussed in numerous conferences between representatives of the Office and officials of the Treasury Department. Procedures have been formulated, satisfactory both to the Treasury Department and to the Resettlement Administration. A

subsidiary problem in connection with the handling of accounts was the establishment of an accounting system on such a basis that various United States attorneys could secure the maximum of information in the most convenient form, in the event that claims required litigation.

The coordination of the lending program of the Resettlement Administration with that of the Farm Credit Administration also involved the drafting of many forms determining the priority of the liens held by the two Administrations, etc. In the course of such work, numerous conferences have been held with various officials of the Farm Credit Administration.

Another phase of this work involved the negotiation of agreements with representatives of the Agricultural Adjustment Administration with respect to set-offs against benefit payments due to persons indebted to that organization.

Under the rehabilitation program of the Federal Emergency Relief Administration, 44 State rural rehabilitation corporations were organized in 1934 and 1935. The work of these corporations was financed with grants made by the Administrator of the Federal Emergency Relief Administration to the various States. The coordination of the work of these corporations with the work of the Resettlement Administration resulted in an unusual legal relationship, particularly since the corporations were organized under State law, and the Resettlement Administration was an agency of the Federal Government. In the summer of 1935 most of these corporations made the Resettlement Administration their managing agent and agreed to transfer their assets to the United States at a subsequent date. The assets of 20 of these corporations were thus transferred subsequent to January 1, 1937, and the problems arising from the novel arrangements embodied in the transfer agreements to the United States by these 20 corporations and by the 14 additional corporations which had transferred their assets prior to that date resulted in a large number of legal questions in connection with the ownership and disposition of the properties of these corporations and the proper methods for their management in conformity with the applicable Federal procedure. Since a great many of the transactions of these corporations were handled in a very informal fashion, some of the problems have been extremely difficult of solution.

Loans to cooperative associations by the Resettlement Administration have been of two kinds:

(1) In one situation, assistance is given to cooperatives composed in whole or in large part of persons residing within resettlement projects, and it has been necessary to assist in the organization of the cooperatives involved. Since January 1, 1937, 41 such cooperatives were organized and 8 others are in the process of organization. In connection with their organization, this Office has prepared 38 sets of articles of incorporation, 39 sets of bylaws, and 37 sets of corporation minutes. It also reviewed and amended seven sets of articles of incorporation and eight sets of bylaws. In connection with these loans, 27 loan applications have been examined to insure the conformity of the associations and the loan agreements with the applicable requirements of law. As security for these loans, and to insure their proper application, 11 contracts, 7 leases, 5 insurance policies, 3 bonds and 18 chattel mortgages and other security instruments have been drawn and executed. Since the applicable executive order required that the cooperatives be conducted under the supervision of the Resettlement Administration, many legal problems have arisen in the administration of these cooperatives. In this connection, it has been necessary to prepare a large number of legal instruments such as construction contracts and contracts for the marketing of agricultural products. This type of loan has also resulted in considerable legal work in connection with various taxation problems that have arisen. It has also been necessary to prepare and file applications for exemptions with appropriate Federal and State officials.

(2) In the other situation, the cooperative is composed in whole or in part of needy farmers. These so-called rehabilitation cooperatives were in many cases existing cooperatives. In such cases it was not necessary to incorporate them. It was, however, necessary to examine their articles and bylaws to determine whether the cooperatives conformed with the standards established by law and, in many cases, to suggest amendments and other legal revisions. It was also necessary to draft a large number of security instruments and to examine some 140 loan applications.

Pursuant to section 2 of the act of June 29, 1936, this Office assisted in negotiations and determinations resulting in agreements to make payments in lieu

of taxes to various local taxing units. In this connection, 21 applications submitted by local subdivisions were examined, 21 agreements prepared and executed, and 21 findings of fact in support thereof drafted. There were also submitted to the Secretary and various administrative officials 61 formal legal opinions on various problems arising in the administration of that section of the act. Section 4 of this act required that all easements and dedications to public bodies be granted only after the approval of the President. Fifteen Presidential letters of approval have been prepared in this connection. There were also drafted for approval a large number of easements, licenses, and similar instruments, both to utility companies and to various local units of government.

In connection with the development, utilization, and occupancy of land on the several resettlement projects, it was necessary to prepare, revise, or modify 33 types of leases, licenses, and sales agreements. Forms of leases and purchase contracts have also been drafted, and the procedure for their use formulated.

A great many legal problems have arisen in connection with the planning and construction of resettlement projects. These projects, in addition to residential buildings, included other structures, as well as parks, roads, and playgrounds, built in such a way as to conform with local law and practice. Perhaps the most difficult and involved of such problems have arisen in connection with arrangements for utility and other public services in connection with the projects.

In order to carry out the administrative decision to transfer completed projects out of the ownership of the Federal Government, it has been necessary to organize a large number of so-called homestead associations to which project properties have been transferred or leased. Five such corporations have been organized and work is in progress for the transfer of two projects. A large amount of legal work has been done in connection with the 12 projects which were transferred to homestead associations at an earlier date. In two instances, legal assistance was rendered in the organization of two municipal corporations, pursuant to State law, embracing two resettlement projects.

Numerous investigation reports have been referred to the Office for legal determination as to civil or criminal liability of employees or clients of the Resettlement Administration. These reports contain all the available evidence relative to alleged irregularities of employees, falsifications or discrepancies involving the possibility of accountability to or claims on behalf of the United States, and cases relating to unauthorized disposition or removal of mortgaged property or misuse of funds by clients. Seventy-nine cases of such irregularities were examined and referred to the Attorney General for appropriate action. These cases were also reported to the Comptroller General, in accordance with General Accounting Office General Regulations 50, Supplement 1. Administrative officials have also been advised as to the civil or criminal action or restitution and settlement recommended. This Office cooperated with the Department of Justice in the prosecution of such cases.

This Office, at the request of Members of Congress, rendered technical assistance in connection with the drafting of the Farm Tenancy Act, and numerous proposals for farm-tenancy legislation before Congress have been examined and analyzed and, in many instances, suggestions for their revision or amendment were transmitted to the appropriate adminstrative officials.

There have been prepared or revised, or assistance has been given in the preparation or revision of 6 Executive orders; 5 Secretary's memoranda; and more than 200 administrative orders, instructions, and notices; and more than 200 legal opinions have been prepared in response to administrative requests on all phases of the work of the Resettlement Administration.

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D.C. - - - - - - Price 10 cents